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Projecting future use of the national forest wilderness system

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CHAPTER I. INTRODUCTION

General

During the past three decades, outdoor recreation use has increased rapidly. This increase has led to overcrowding of specific sites, and in some instances, to adverse impacts on recreation sites as well as on other important uses of forests and rangelands. Wilderness recreation has shown an even greater increase than other forms of outdoor recreation with roughly a 15-fold increase since World War II (U.S. Forest Service, 1977). Future increases in population, available leisure time, disposable income, and mobility will almost certainly contribute to increased use of and demand for outdoor recreation facilities although the increases may not be as large as in years past.

With this increased use and demand, and with visitors indicating distaste for congested areas (Cicchetti, 1973), it is evident that there is a need for a sound method for determining future use of and demand for recreation resources. This is particularly true of wilderness areas. If steps are not taken soon to supply adequate wilderness areas for the future, areas which presently qualify for inclusion in the wilderness system may undergo changes which prevent their inclusion later. Conversely, inclusion of too many areas either in total, or within specific regions would mean vast amounts of land removed from uses which might be more productive if these areas are not needed for wilderness in the future.

Several techniques are available for projecting use or demand for outdoor recreation, but many have serious shortcomings, and they have not been widely used in attempts to project demand for wilderness. Depending on the situation, misleading results may be obtained due to: failure to distinguish between use of a site and economic demand for the site, failure to clearly specify the intended use for the projection technique, and failure to account for substitute activities which may be available.

Visitor use or economic demand

There is a tendency for researchers and laymen alike to apply the words "use" and "demand", when talking about outdoor recreation sites, as if the two were synonymous (Burdge and Hendee, 1972). The two are generally not interchangeable, and this has led to confusion on the part of laymen and misinformed statements on the part of researchers and land managers. Outdoor recreation "use" is the measured number of visits or number of visitor days to a specific site. It is, thus, consumption under a particular set of circumstances. On the other hand, "demand" in the economic sense is "a conditional statement of participation that would result at a given time and in a given place under a specific set of conditions and assumptions about an individual and his or her social relationships and the availability of recreation resources" (National Academy of Sciences, 1975). It is, then, a relationship between quantities that would be consumed at varying prices. Thus, for any given price there would be an amount demanded. To illustrate the difference between use and demand, take a hypothetical case of an area which has no lakes large enough for waterskiing. Use of existing lakes for water-skiing is, therefore, zero because of size limitations. There may be, however, a significant number of people in the area who would waterski if the opportunity were provided through a large enough lake. The amount of waterskiing done would vary depending upon the price at which the opportunity was provided. This relationship between amount of waterskiing done and price of opportunity would be demand. Once a lake was provided, a price for the opportunity would be known, and a certain amount of waterskiing would be demanded. Thus, "use" is a measure of consumption not of demand. Further, "use" can be construed as an amount demanded at a given price only if supply does not limit consumption. The assumption that supply does not limit consumption of outdoor recreation may not be valid in many cases.

Specification of intended use

Depending on the information needs of land planners and managers, use projection may provide valid information for the planning process. Certainly if the manager's aim is to supply adequate facilities at a particular recreation site, and planning horizons are short, use projection will supply useful information. One must keep in mind, however, that as plans are extended further into the future, the possibility of changes in user preferences, supply of similar recreation sites, or supply of substitute activities will cause projected use figures to become less meaningful. "Improper accounting of supply considerations leads, for instance, to the assumption that people demand only increasing quantities of what they now have, thereby perpetuating present imbalances" (Knetsch, 1969).

Similar problems can arise when attempting to develop demand curves based on time-series data. If allowances are not made for shifts in supply and demand curves over time, time-series data may not yield the expected demand curve (Working, 1927; Kalter and Gosse, 1970).

If the aim is to make long-range plans for a specific site, or to determine an optimum number, type, and location of sites, then projection techniques which incorporate concepts of supply and substitution must be used.

The problem of substitutes

While overlooking aspects of supply can lead to serious errors, it may be true that overlooking substitute sites and activities is equally serious. "The substitutability concept refers to interchangeability of recreation activities in satisfying participants' motives, needs, and preferences" (Hendee and Burdge, 1974). Substitutability is a two-edged sword, however. If there are effective substitutes for wilderness-type recreation, failure to account for them will almost certainly lead to projected demand in excess of actual demand. Alternatively, if there are no substitutes for wilderness recreation, this should be made apparent to prevent policies which "...would completely disfranchise habitual users and unique values, creating a far more serious impact than if substitutes are available" (Hendee and Burdge, 1974).

Techniques Presently Available

With these problems in mind, it is possible to review existing techniques for projection with the idea that they may form the basis of a useful projection system for wilderness use.

Projection techniques center on three basic data sources as identified by Cicchetti (1973). The three are, population-specific, site-specific user oriented, and site-specific area oriented. Information generated by population-specific studies can be used to forecast expected use levels by activity for a region using data from household surveys. While the ability to forecast for a region is highly desirable for the wilderness problem, techniques project use rather than demand, and currently available population-specific data may be one of the weakest data sources since it gives no indication whether certain activities occur in wilderness areas, or in adjacent nonwilderness areas.

Site-specific user oriented techniques rely on on-site interviews to forecast use at a specific site and may yield necessary information for efficient management of the site (Hendee et al., 1968). Without modification, this technique will not provide information useful in evaluating proposed sites.

Through counts of users, site-specific area oriented techniques are useful for evaluation of short-run benefits provided by a site, but the technique is not readily adaptable to wilderness use projection problems in long-range planning processes.

A review of specific techniques available in each of these categories will illustrate their strong points and shortcomings.

Population-specific techniques

Perhaps the most widely known population-specific technique is that used by the Outdoor Recreation Resources Review Commission (O.R.R.R.C.) in

1962 to make projections for 17 outdoor recreation activities for the years 1976 and 2000. Data for the study came from a sample of persons 12 years of age and older (O.R.R.R.C., 1962a). While the study purports to project demand for the activities listed, what is actually being projected is number of visits, and thus use, not demand, is actually being projected.

As with many techniques, socio-economic factors are used in an attempt to find a relation between number of visits and a set of socio-economic variables in hopes that the relationship will continue unchanged at least through the projection period. The O.R.R.R.C. study regressed visits on various combinations of family income, education, employment, place of residence, sex, and age. This approach produced coefficients of determination from 0.95 to 0.99, results which would make the approach extremely useful for projection of use three to five years into the future.

Two factors make more distant projections questionable. First, in order to make a use projection, one must project levels of socio-economic variables to the future. Consequently, errors in projection of socio-economic variables will certainly result in errors in projected use. Unfortunately, this is a shortcoming of all such techniques and the only remedy appears to lie in improvement of projection techniques for the socio-economic variables. The second problem lies in the assumption that the relationship between use and the independent variables will remain constant over long periods of time. There are at least two reasons to believe this is not so. Use levels at a particular site may change due to major improvement, new developments, different activity patterns, or changes in user preferences (Campbell, 1976). Such changes may take place in as little as three to five years, and since these variables are not included in the model, it is not capable of discerning such changes. A second factor responsible for changes in use relationships is that of supply. As shifts in the supply of recreation areas occur, it is reasonable to assume that people who previously showed little or no inclination toward outdoor recreation may begin to participate. Since the O.R.R.R.C. model contains no supply variables, such changes will go undetected unless the model is "recalibrated" every few years and projections are limited to time spans of perhaps five years or less.

A second study of this nature was carried out for the state of Iowa in 1973 (Manning _et al_., 1973). Like the O.R.R.R.C. study, a sample of Iowa residents 12 years of age and over was taken. Twelve independent variables were used to predict participation levels for 24 activities for the years 1976 and 1980. The only major difference between this study and the O.R.R.R.C. study is that age squared and income squared were used to determine whether use was related in a nonlinear fashion to changes in age and education. The technique for making predictions was the same as for the O.R.R.R.C. study and again, no substitute or supply variables were used. The one advantage is that the projections were made for a shorter period than the O.R.R.R.C. study which probably reduced the seriousness of error due to changing relationships between variables.

Another study using single equation regression techniques is that of Kalter and Gosse (1969) in an attempt to project per-participant demand for camping, boating, hiking, fishing, and swimming in New York. Using data from families who had participated in outdoor recreation activities, several equation forms were tested with best results from double log transformations. However, "there are two fundamental errors in their approach. First, the participation reported in the survey is total participation and is not segmented by site. Additionally there was no way of discerning the diversity of supply opportunities available to an individual in the survey" (Cicchetti, 1973).

To remedy some of the difficulties in previous studies, Cicchetti (1973) has developed a method for forecasting participation in certain recreation activities which incorporates, to some extent, supply and substitute variables, and a method for deflating estimates where congestion occurs on site. In addition to these improvements, Cicchetti also uses a two-step approach to estimate total days of participation for various activities of interest. In the first step, he estimates the probability that a person will participate in a particular activity. To do this, Cicchetti uses the same sort of socio-economic variables used by the O.R.R.R.C. study. In addition to these, however, he uses such variables as number of acres of high intensity recreation land per capita in the sampling area, distance from a major body of water, other commercial recreation establishments, number of overnight visitors to recreation areas in the state, and other similar variables as measures of supply, depending on the activity being dealt with. Supply variables are deflated by dividing by total population in the area. From this, the expected number of participants from the total population is determined.

The second step involves determination of days of recreation per participant. Again, socio-economic variables and supply variables are used to make the prediction, but supply variables are now divided by number of participants in an attempt to measure congestion. Once number of participants and number of recreation days per participant have been determined for the activities of interest, total recreation days for each activity are determined by multiplying the two estimates together. Schreuder (1975) states that this two-step approach reduces the standard error in comparison with those methods which try to predict participation rates for an activity for participants and nonparticipants alike. He further contends, however, that Cicchetti uses too many independent variables (as many as 20 per equation) for prediction purposes.

The adjusted coefficients of determination for the two equations are quite low for the various activities, typically ranging from 0.15 to 0.22. In addition, no mention is made of the error associated with the final estimate of days of participation by activity.

A second study of this nature was conducted by the Bureau of Outdoor Recreation (Adams et al., 1973). The first step involved estimation of the proportion of the population involved in outdoor recreation and secondly, the estimation of per capita quantity demanded of each activity on each occasion. Regional conditional demand equations for 23 activities are presented in the study. An improvement over the Cicchetti material lies in the presentation of estimated confidence intervals around the estimated conditional demand functions.

The approach has been carried one step further in the Upper Great Lakes Regional Recreation Planning Study (Cooper et al., 1974). This study used a sample of households in an area defined by the nine states of Illinois, Indiana, Iowa, Michigan, Minnesota, Ohio, Wisconsin, North Dakota, and South Dakota. Rather than the two-step approach used by Cicchetti, however, this study used a four-step approach.

> "The first step of the analysis identifies the group that takes recreational trips and, specifically, trips to the Upper Great Lakes Region. The second step of the analysis determines the subset that participates in outdoor recreation activities on an activity by activity basis. The third step concentrates on families who take trips and participate in a given activity, and generates the level of participation for each of the twelve recreation activities. And, the fourth step involves distributing the total days of participation over the Upper Great Lakes multicounty zones" (Cooper et al., 1974).

The study includes socio-economic variables, youth-related variables, and supply variables. Despite the four-step approach, coefficients of determination remain low (.09 to .39), and no estimate of error for the final projection is made.

These four studies are indicative of the approach based on population-specific data. Improvements in the technique probably do not lie in the direction of more variables and more conditional steps. Careful selection of a limited number of variables which include measures of substitution as well as supply will be needed to generate long-range use projections suitable for planning. The general approach, however, has merit in that regional and national projections for wilderness can be readily made by this technique once appropriate variables are determined and data is collected.

Site-specific user oriented techniques

Site-specific user oriented data is obtained from interviews conducted on the recreation site of interest. Information obtained through such interviews can be used in three ways, 1) user preferences can be used as a basis for short-term planning and management of the site and to gain insight into the types of additional sites users prefer, 2) information on use rates and socio-economic factors coupled with supply variables can be used to project future use for the site, and 3) using an approach developed by Clawson (1959), a demand curve for the site can be approximated.

With further exploration into site-specific data, a fourth use may evolve. Site-specific data is, quite often, more abundant than population-specific data, and with modification in techniques of projection, site-specific user oriented data may be used in making regional projections. Certainly it seems reasonable that similar sites in similar locations would have similar use. It may be possible, through proper accounting of important factors, to project use of one site based on use of other similar sites, and ultimately to make projections for proposed sites based on projections for existing sites. Somewhat similar techniques have been developed for estimating use on some sites based on use of other sites in the area (Bury and Margolies, 1964; James and Rich, 1966; and Wagar, 1964). Two examples will illustrate the uses of site-specific user oriented data.

In order to properly manage wilderness areas, managers must be sensitive to the aspects of wilderness valued by users (Hendee *et al.*, 1968). One way to obtain such information is to interview wilderness users on site. The type of information one can obtain from such procedures is nearly unlimited, and along with user preferences, rather extensive lists of user-related socio-economic and demographic information can be obtained (Lucas, 1970). Information regarding tastes and preferences can be used to evaluate present management goals and may serve as an indicator of need for new sites. If supply and substitute variables are accounted for, future use of the site may be approximated.

Since interviews are conducted only on those people actually using the site, care must be exercised in making generalizations about regional use based on site use. There does, however, seem to be potential for developing measures of similarity between sites, either existing or proposed, and between surrounding areas which will allow use of site-specific information in regional projections.

Perhaps the most widely known method for projecting recreation demand curves was developed by Clawson (1959). By interviewing visitors to certain recreation areas, he was able to develop a technique which estimates the demand curve for a particular site. The method uses two stages, the first developing demand for the total recreation experience, and the second developing a demand curve for the recreation resource.

Information necessary to estimate demand for the total recreation experience consists of distance traveled by the party to reach the site, estimated cost to the party per visit and estimated number of visits during some time period of interest. In addition, the area surrounding the site must be divided into distance zones and population within each zone determined. Thus, people traveling 18 miles to the site might be placed in a "less than 50 miles" zone, persons traveling 70 miles in a "50 to 100 miles" zone and so on. From this, it is possible to determine visits per 1,000 base population from which a graph can be constructed. Using hypothetical data from Clawson and Knetsch (1966), the graph in Figure 1 can be produced.

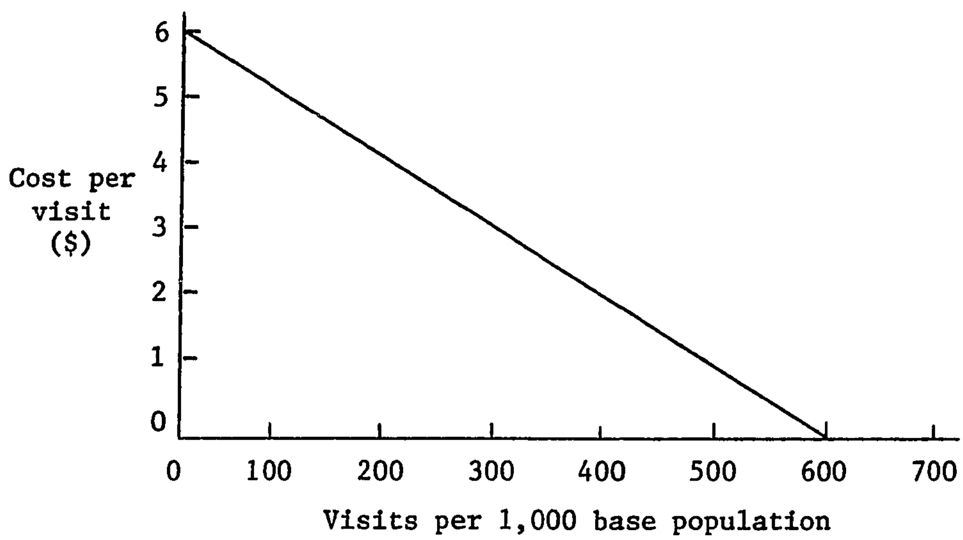


Figure 1. Demand for the total recreation experience

Once this relationship has been determined, it is possible to construct a demand curve for the recreation resource. For instance, when cost per visit is five dollars, there are 100 visits per 1,000 base population. If this price were to rise to six dollars per visit due perhaps to imposition of a one dollar entrance fee, the assumption is that number of visits would fall to zero as indicated by the present visitation rate at a price of six dollars. This information coupled with base population for the appropriate distance zone will give expected number of visits from that zone assuming a one dollar increase. If the effect of a one dollar increase is calculated for each zone and results for each zone are added together, the result is total expected visits after the increase (in this case, 1,200 visits). If the same calculation is carried out for several different prices, a demand curve such as the one in Figure 2 will be traced out.

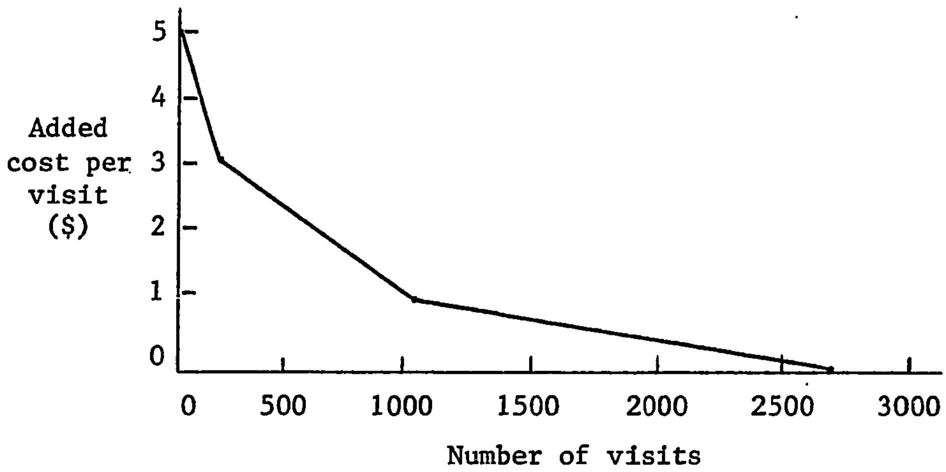


Figure 2. Estimated demand curve for a hypothetical recreation site

While this is a demand curve in the true sense of the word, there are limitations. The approach deals with supply only at the time the curve is constructed and consequently is subject to possible error if projected too far into the future. There is also a problem in that time costs of the trip are ignored (Cesario, 1976). Take, for example, trips to a recreation site from two zones of origin, zone 1 which is five minutes away, and zone 2 twenty minutes away. Further assume that the cost of a visit from zone 1 is two dollars, from zone 2 three dollars, and that present visitation rates are 500 and 300 visits, respectively. The Clawson approach would infer a visitation rate of 300 from zone 1 if cost per visit to zone 1 visitors increased by one dollar. That is, since the price to zone 1 is now three dollars, the visitation rate must drop to that level shown by zone 2 when its cost was three dollars. However, since people in zone 1 are closer to the site than are people in zone 2, they may continue visitation at a higher rate since their time cost is less. This problem can be corrected by incorporating travel time along with costs as an independent variable in the analysis used to establish the demand curve (Beardsley, 1971).

Other reasons for doubting the assumption that the demand schedule is the same for all zones is the fact that the propensity to visit a park may vary with income, age, population densities, available alternatives, other close substitutes and other socio-economic variables (Knetsch, 1963). These factors would certainly be expected to change from zone to zone if the area of study is large enough to accomodate a majority of users of a particular wilderness site.

As a result, Clawson's approach is useful (with modification to reflect differences in demand schedules from zone to zone) in developing a demand curve for a specific wilderness area under varying costs to the user. Whether the method would be useful for wilderness demand projection would depend on modification of the technique to allow development of a demand curve for proposed sites based on the demand for similar existing sites.

Site-specific area oriented techniques

The third type of projection technique will be mentioned only briefly since models of this type are intended for estimation of use for a specific site over rather limited time spans. The technique normally involves double sampling during a calibration year in order to relate number of visits or number of visitor days to more easily measured variables such as traffic meter readings or water meter readings (Promnitz *et al*., 1976; James, 1967; James and Tyre, 1967). Because the technique was developed specifically for use estimation at existing sites it is not practical for wilderness use projection although use estimates for other types of sites based on this technique could provide useful information for determining if wilderness substitutes exist.

Scope and Objectives of This Study

This study was sponsored by the U.S. Forest Service's Resource Program and Assessment Staff. The Forest Service is charged with assessing the present and anticipated uses, demand for, and supply of the renewable resources of forest, range, and other associated lands (U.S. Forest Service, 1977). Among these resources is the wilderness system within the National Forests. In order to assess future demand for wilderness within the system, it is necessary to estimate future use of that system.

This study involves two general objectives:

(1) To develop a technique for projecting wilderness use based on factors of wilderness supply and demand, and socio-economic characteristics of the regional population.

(2) To indicate where deficiencies in data exist and suggest possible remedies.

The first part of the study deals with investigation of variables of a socio-economic nature which have been used previously to project recreation use. From these, a subset of variables is selected for use in model development. Two models are developed, one utilizing a time-series, cross-section type of regression, and the second utilizing ordinary least squares regression but incorporating previous year's wilderness use as an independent variable.

The question of substitute activities is addressed using Forest Service data and data from the National Park System.

The second objective is dealt with through suggested improvements in type and frequency of data collection.

CHAPTER II. SOCIO-ECONOMIC VARIABLES AND DATA SOURCES

Socio-economic Variables Studied

During the past 20 years, there have been a number of studies relating outdoor recreation to socio-economic characteristics of the participants. These studies represent many different areas of the United States and have dealt both with wilderness recreation specifically, and with outdoor recreation in general. Even though there is considerable overlap in the socio-economic variables used, there is a rather long list of variables which might prove useful in projecting wilderness use on a regional and national basis.

This chapter: (1) shows the range of variables which have been used in past studies, (2) indicates which variables have been most widely used, (3) gives justification for selection of a reasonable number of variables upon which to base a wilderness projection model, and (4) indicates data sources for the variables selected.

A computerized search of literature was conducted using the following key words: wilderness use, wilderness demand, primitive area, roadless area, and outdoor recreation in conjunction with socio-economic, age, income, occupation, leisure time, and census sampling. The variables reported in this chapter were used in one or more of the studies so located.

For each variable used in relation to wilderness, the variable name is given along with a brief description of the variable, the manner in which it is usually recorded, and the usual relationship between wilderness use and the variable. Of the two numbers listed directly after the variable name, the first indicates the number of wilderness studies in which it was used and the second, the number of outdoor recreation studies in which it was used.

Family income (6, 10)

The most commonly used values are annual family income. Data is usually reported as a percent of users within a given income bracket. For convenience in making projections, the standard Bureau of Census categories are recommended. Most studies show that the majority of wilderness users are from middle and upper income groups (Burch and Wenger, 1967; Lucas, 1964; Lucas, 1970; Merriam and Ammons, 1967; O.R.R.R.C., 1962b; Vaux, 1975). Ten nonwilderness studies were found which gave percentage listings of users by family income classes (B.O.R., 1965; B.O.R., 1972; Cicchetti, 1973; Cooper *et al*., 1974; Gray and Blair, 1971; King, 1968; Lindsay and Oglo, 1972; Manning *et al*., 1973; O.R.R.R.C., 1962a; White, 1975) (Appendix 1).

Education completed (7, 10)

This variable is commonly recorded as percent of users who have attained a certain level of education. Normally, only responses of persons 25 years and older are recorded. In most wilderness areas studied, the majority of users have some college education and many have completed four years of college and have some post-graduate training (Burch and Wenger, 1967; Hendee *et al*., 1968; Lucas, 1964; Lucas, 1970; Lucas and Oltman, 1971; Merriam and Ammons, 1967; O.R.R.R.C., 1962b) (Appendix 2).

Ten of the studies reviewed dealt with educational attainment in relation to nonwilderness outdoor recreation (B.O.R., 1965; B.O.R., 1972; Cicchetti, 1973; Cooper et al., 1974; Gray and Blair, 1971; King, 1968; Lindsay and Oglo, 1972; Manning et al., 1973; O.R.R.R.C., 1962a; White, 1975).

Occupational status (7, 7)

This variable is usually presented as percentage of users within an occupational type such as professional-technical, managers, craftsmen, etc. Some studies include student as an occupation while others ask for student status as a separate question. Professional-technical, craftsmen, foremen, and student type occupations account for a majority of the wilderness users in most studies (Burch and Wenger, 1967; Lime and Lorence, 1974; Lucas, 1964; Lucas, 1970; Lucas and Oltman, 1971; Merriam and Ammons, 1967; O.R.R.R.C., 1962b). Seven nonwilderness studies were found which relate occupational status to outdoor recreationists (B.O.R., 1972; Cicchetti, 1973; Cooper et al., 1974; Gray and Blair, 1971; King, 1968; O.R.R.R.C., 1962a; University of Wisconsin, 1970) (Appendix 3).

Age (6, 9)

While age may be reported as percent by year, it is usually reported as percent of users within certain age categories. In most areas studied, the majority of wilderness users are between 24 and 54 years old (Hendee et al., 1968; Lime and Lorence, 1974; Lucas, 1964; Lucas, 1970; Lucas and Oltman, 1971; O.R.R.R.C., 1962b). Nine nonwilderness studies were found which categorized recreationists by age class (B.O.R., 1965; B.O.R., 1972; Cicchetti, 1973; Gray and Blair, 1971; King, 1968; Lindsay and Oglo, 1972; Manning et al., 1973; O.R.R.R.C., 1962a; University of Wisconsin, 1970) (Appendix 4).

Sex (4, 7)

Male wilderness users account for more than two-thirds of all users in nearly all studies. In some cases, responses concerning other characteristics are separated by sex of the respondent, thus giving an indirect estimate of users by sex (Lucas, 1964; Lucas, 1970; Merriam and Ammons, 1967; O.R.R.R.C., 1962b). Seven nonwilderness studies were found which categorized recreationists by sex (B.O.R., 1965; B.O.R., 1972; Cicchetti, 1973; Gray and Blair, 1971; Lindsay and Oglo, 1972; Manning et al., 1973; O.R.R.R.C., 1962a).

Vacation length (3, 4)

This is usually reported as percent of users by weeks of vacation. A typical breakdown is 0, 1, 2, 3, or 4 or more weeks of vacation. The majority of the wilderness users have 2 to 3 weeks of vacation (Burch and Wenger, 1967; Lucas, 1970; O.R.R.R.C., 1962b). Four nonwilderness studies categorize recreationists by vacation length (Cooper et al., 1974; Gray and Blair, 1971; King, 1968; University of Wisconsin, 1970).

Population of present residence (3, 8)

Percent of users by residence population class is usually broken into several population ranges from rural to cities in excess of

1,000,000. Typically, wilderness users are from towns and cities ranging from 5,000 to 50,000 population (Burch and Wenger, 1967; Lucas, 1970; O.R.R.R.C., 1962b). Eight nonwilderness studies used some form of residence population to categorize recreationists (B.O.R., 1965; B.O.R., 1972; Cicchetti, 1973; Cooper _et al._, 1974; Lindsay and Oglo, 1972; Manning _et al._, 1973; O.R.R.R.C., 1962a; University of Wisconsin, 1970).

Marital status (4, 3)

This is usually reported as percent of users in each of four categories: single, married, widowed, or divorced. From one-half to three-fourths or more of the wilderness users are married with nearly all the remainder single (Hendee _et al._, 1968; Lucas and Oltman, 1971; Merriam and Ammons, 1967; O.R.R.R.C., 1962b). Three nonwilderness studies were found dealing with marital status (Cicchetti, 1973; Cooper _et al._, 1974; Gray and Blair, 1971).

Membership in conservation group (5, 0)

Response concerning this variable may be recorded in one of three ways:

1. Member of conservation groups? (yes/no)
2. Member of specific conservation groups? (yes/no)
3. Member of how many conservation groups?

The percentage of people belonging to conservation clubs tends to vary rather widely from one area to another, but few users (typically 30% or less) belong to a conservation club (Hendee _et al._, 1968; Lucas, 1970;

Lucas and Oltman, 1971; Merriam and Ammons, 1967; O.R.R.R.C., 1962b).

Size of childhood residence (4, 1)

This is generally reported in the same manner as present residency population but deals with childhood residence. Most wilderness users grew up in towns of 5,000 to 50,000 people (Burch and Wenger, 1967; Hendee et al., 1968; Lucas, 1970; O.R.R.R.C., 1962b). Only one nonwilderness study (Gray and Blair, 1971) was located which deals with size of childhood residence.

Number of children (2, 3)

This is generally reported as percent of people by number of children. Most wilderness users have from one to three children. Relatively few have no children (Burch and Wenger, 1967; Hendee et al., 1968). Three of the nonwilderness studies categorized recreationists by number of children (Cooper et al., 1974; King, 1968; Lindsay and Oglo, 1972).

Age of the youngest child (1, 2)

This is usually recorded as percentage of users by youngest child's age. Only one wilderness study was found dealing with this variable. It indicated that of the people with children, 33% had a youngest child between one and four years old. The remaining 67% were spread about uniformly across the age ranges 5-9, 10-14, 15-20, and 21 and over (Burch and Wenger, 1967). Two nonwilderness studies listed percent of users by age of youngest child (B.O.R., 1965; King, 1968).

Age of the oldest child (1, 0)

Response to this question is recorded as percent of users by age of oldest child. Burch and Wenger (1967) indicated nearly a uniform distribution of users by age of oldest child.

Age group married male and age group married female (1, 0)

This is a combination of the age and sex variables previously discussed to produce percentage of married users by age and sex. Burch and Wenger (1967) indicated that the majority of the married people using the study area were between the ages of 30 and 64 regardless of sex.

Shift in residence location (1, 0)

The study by Burch and Wenger (1967) lists number of people interviewed who shifted residence location from: rural to urban, urban to rural, rural to rural, or urban to urban. As expected, the majority of the shifts were rural to urban or urban to urban.

Age at first camping (2, 0)

This is percentage of users by their age at the first time they camped. The majority of wilderness users had visited a wilderness area for the first time before the age of 15 (Burch and Wenger, 1967; Lucas, 1970).

Student status (2, 0)

This is the percentage of users who are presently students. This variable may be included in the list of occupation types. Students account for a significant portion of wilderness use in most areas (Lucas, 1970; Lucas and Oltman, 1971).

Church membership (1, 0)

This is the percentage of users who are members of a church. O.R.R.R.C. (1962b) indicated that 75% or more of the users in nearly all areas studied were church members.

Type of housing (1, 0)

This is the percent of users by type of home. Most wilderness users live in single family homes according to O.R.R.R.C. (1962b).

Several of the nonwilderness studies have categorized recreationists by variables which have not been used in wilderness research. Such variables are: race, size of family, employment status, and homeowner (Cicchetti, 1973), length of residence and age of each child (Lindsay and Oglo, 1972), leisure time on weekdays and leisure time on weekends (Manning et al., 1973), ethnic origin and hours worked per week (Gray and Blair, 1971), childhood experience (Yoesting and Christensen, 1976), and state origin (University of Wisconsin, 1970).

Selection of Variables for Model Development

While the studies cited indicate the possibility of using some 30 different socio-eonomic variables, it is neither possible nor desirable to include all of the variables in a wilderness projection model.

Since this study is limited to the use of data presently in existence, it seems reasonable to limit discussion to those variables for which the data is most available provided it is dependable and can be reasonably incorporated into a projection model. If this is done, it becomes apparent from the number of wilderness studies in which a particular variable has been used that family income, educational attainment, occupational status, age, sex, and population of present residence have been studied most often in relation to wilderness and hence should have the most data available. Data for these variables are also available from the Bureau of Census. Occupational status presents problems, however, in that categories differ between studies and category definitions are sufficiently vague to make comparisons between studies difficult, if not impossible. In addition to this, at least one researcher (White, 1975) has found occupational status unimportant in predicting activity type or level when using education and income in the same model. His findings indicate that:

> ". . .when multiple regression analysis using the data are computed with variety of activities and activity level as dependent variables, it is evident that occupational level is not an important predictor in either case. Instead, education, income, and age are the important predictors for both dependent variables.
>
> Occupation is significantly correlated with income and education (.39 and .57, respectively) for the sample . . . of the three socioeconomic variables (education, occupation, and income), education is the most important predictor of outdoor recreation participation . . . partial correlation results reveal that education and income have independent contributions in outdoor recreation behavior, and that occupation does not."

While his findings are based on data for less dispersed types of outdoor recreation rather than wilderness, it seems reasonable that similar conclusions could be drawn for wilderness. For this reason and because of vagueness of occupational categories, occupational status was not included as a variable in the projection models developed.

The obvious way in which to develop a projection model for wilderness would be to regress wilderness use in a region against socio-economic characteristics of wilderness users within the region along with other explanatory variables as necessary. Unfortunately, existing data will not permit such an approach. To do so would require use figures for the region for a number of years and observations on socio-economic characteristics of wilderness users for each of those years. While the wilderness use figures are available, observations on socio-economic characteristics of the users are not consistently available even for a single wilderness area let alone for a whole region.

After considering data availability and data reliability, the following variables were chosen for further study in development of projection models:

1) wilderness use (dependent variable)
2) regional wilderness acreage
3) number of national forest wilderness areas in each region
4) regional population
5) national population
6) regional median family income
7) regional percent of families by each of eight income classes
8) national median educational attainment of males 25 and older
9) national percent of males within each of seven education classes

10) national median educational attainment of females 25 and older
11) national percent of females within each of seven education classes
12) national median male age
13) national percent of males within each of seven age classes
14) national median female age
15) national percent of females within each of seven age classes

Variable Description and Data Sources

Data for the study were compiled for the years 1966 to 1975 from several sources. The type of data and the source from which it was obtained are further explained in this section.

Wilderness use figures were obtained from the U.S. Forest Service for each wilderness and primitive area within the system. These were then aggregated to the regional level giving wilderness use in visitor days for each region.

Wilderness acreage was aggregated to the regional level using information from Wilderness U.S.A. (National Geographic Society, 1973).

Number of wilderness areas within each region was also obtained from U.S. Forest Service information. Wilderness use, wilderness acreage, and number of areas include only National Forest Wilderness and Primitive Areas.

Regional population figures were obtained from two sources. For the years 1966 through 1969, data from the Obers Projections (U.S. Department of Commerce, 1972) were used. Population values for each state were summed to yield regional population values. For the years 1970 to 1975, population estimates for each state were obtained from the Bureau of Census publication Estimates of the Population of States With Components of Change: 1970 to 1975.

> "The population estimates contained in this report were developed by averaging the results of three methods. Each of these methods uses current data to estimate population change since April 1970. These methods are 1) the Census Bureau's Component Method II, which employs vital statistics to measure natural increase and elementary school enrollment data to eliminate net migration; 2) the Ratio-Correlation method, in which a multiple correlation estimating equation is applied to the changes in distribution of four different series of data to estimate changes in population; and 3) the Administrative Records method, where net internal migration is estimated using individual income tax returns. Immigration from abroad is developed separately from reports on intended residence of immigrants, and vital statistics are used to estimate natural increase" (U.S. Bureau of Census, 1976).

National population estimates were obtained from the same source as regional population estimates by aggregating estimates for all states.

Regional median family income values were obtained from the Bureau of Census publication, Consumer Income: Money Income in 1975 of Families and Persons in the United States. The data comes from a revised system which was implemented in an effort to reduce nonsampling error in the estimates (U.S. Bureau of Census, 1977). The census regions used do not correspond exactly to U.S. Forest Service regions, so adjustments were made. Data from the Northeast Census Region were used for region 9. Data from the South Census Region were used for region 8, and data from the West Census Region were used for regions 1 through 6. All median family incomes were reported in 1975 dollars.

The percent of families within each region by income class were obtained from the same source. Adjustments were made to match census regions to U.S. Forest Service regions in the same manner as for median family income values. Eight income classes in 1975 dollars were used. Data collected consisted of the percent of families within a region in each of the income categories. The categories used were: 1) under $3,000, 2) $3,000 to $4,999, 3) $5,000 to $6,999, 4) $7,000 to $9,999, 5) $10,000 to $11,999, 6) $12,000 to $14,999, 7) $15,000 to $24,999, and 8) $25,000 and over (U.S. Bureau of Census, 1977).

All educational attainment data were obtained from Bureau of Census Current Population Reports (series P-60) for the appropriate year. Median educational attainment for males and females is in terms of years completed for persons 25 years of age and older. In addition to median values, the percent of males and percent of females by years of education for each of seven classes was used. The classes used were: 1) less than 8 years, 2) 8 years, 3) 9 to 11 years, 4) 12 years, 5) 13 to 15 years, 6) 16 years, and 7) 17 or more years of education completed.

Data for median male age and median female age were collected from the Bureau of Census publication Current Population Reports, Population Estimates and Projections (1975).

Data for percent of males and percent of females by age class were obtained from Bureau of Census Current Population Reports (series P-60) for the appropriate years. Data consists of the percent of the population 14 years of age and older in each of seven age classes. Age classes used are: 1) 14 to 19 years, 2) 20 to 24 years, 3) 25 to 34 years, 4) 35 to 44 years, 5) 45 to 54 years, 6) 55 to 64 years, and 7) 65 years and older.

CHAPTER III. EFFECT OF SUBSTITUTE ACTIVITIES ON WILDERNESS USE

General

One area of concern which must be dealt with in developing a model for projecting wilderness use is whether or not other activities may act as substitutes for wilderness recreation. In an economic sense, two goods are substitutes if an increase in the quantity of one reduces the marginal utility of the other. If such a relationship exists between wilderness use and other forms of recreation, it may affect the amount of wilderness use in the future. Increased recreation in a substitute activity would be accompanied by decreased wilderness use and vice versa. When substitution exists but is not accounted for, it may lead to projected use in excess of that actually experienced. Such projections might then be erroneously used as a basis for unnecessary increases in the wilderness system. Conversely, if substitute activities do not exist, such knowledge is important to prevent "foreclosing opportunities which would completely disfranchise habitual users and unique values, creating a far more serious impact than if substitutes are available" (Hendee and Burdge, 1974).

While substitute relationships may exist between wilderness use and similar activities such as hiking or remote camping, the problem is compounded by the possibility that substitution may also exist between wilderness recreation and very dissimilar activities such as attending concerts or playing chess. Such a relationship between backpacking and chess playing is supported in work done by McKechnie (1974), leading one to believe that dissimilar activities might substitute for wilderness. In addition to this, suitable substitutes may differ in the mind of the user depending on his or her age.

Determination of relationships between wilderness recreation and such diverse activities as chess and attending concerts would require more and different data than is available to this study. Such data would most readily be obtained through properly worded personal interviews or mailed questionnaires. Likewise, data necessary for determination of changes in substitutes with changes in user's age is not available for this study.

Intuitively, it would seem that if substitution exists between other activities and wilderness recreation, it would be most noticeable in similar types of outdoor recreation such as camping, hiking, or related activities. While not extensive, some data is available to test this hypothesis and provide a basis for inclusion or exclusion of substitute activities in the projection models.

Test for Substitution Between Wilderness Recreation and Related Activities

Use data for four activities within national forests, and for visits to national parks was used to test the hypothesis that similar activities may substitute for wilderness recreation. The national forest activities were picnicking, camping, hiking and mountain climbing, and winter sports. Data for the activities consisted of visitor days of use in each activity for U.S. Forest Service regions 1 through 6 for the years 1966 through 1976. Data for the national parks were number of visits to parks for each region over the same time period. In addition to this information, visitor days of use of U.S. Forest Service wilderness areas for each region for the 11-year period were also collected. The choice of these activities was dictated by the fact that they provided, to some extent, similar experiences to wilderness recreation, and also because use estimates for these activities were deemed to be more reliable (and therefore would give a better chance of showing substitution if it existed) than other activities for which less reliable data were available.

If substitution between wilderness recreation and any one of these activities does exist, then increased use in the alternate activity should be accompanied by decreased wilderness use. Thus, in a regression of wilderness use on use in the alternate activity, a negative coefficient associated with the alternate use would suggest existence of substitution between the two.

During the period for which data were collected, there was a marked increase in all recreation activities tested. To account for this increase, a time trend was included in each regression equation. Data from each region for each of five activities were analyzed with the following model to test for substitution:

$$WU_i = \alpha + \beta(yr) + \gamma(AU_i)$$

where

WU_i = regional wilderness use in year i

$i = 66$ to 76

yr = the year in which the use occurred

AU_i = use in an alternate form of recreation during year i

and α, β, and γ are coefficients to be determined by ordinary least squares regression.

Coefficients for each region and activity are shown in Table 1. The coefficient associated with the alternate activity was negative in only six of thirty instances, and for those six which were negative, none were significantly different from zero at the 99 percent level. Thus, there is no evidence, based on this data, that substitution between wilderness use and the other activities exists in sufficient magnitude to be of importance in the projection models developed in this study. These findings are in agreement with the statement by Hendee and Burdge (1974) that "activities for which there are no substitutes tend to be area-based such as in wilderness and natural or historical areas."

It should be emphasized, however, that the regression technique used here will yield negative coefficients for alternate activities only when those activities are in fact being substituted for wilderness recreation. It may be that certain types of recreation would provide nearly perfect substitutes for wilderness under appropriate circumstances, but are not being utilized as substitutes at present. Additionally, if

Table 1. Regional coefficients for alternate activities

Coefficient	Region 1	Region 2	Region 3	Region 4	Region 5	Region 6
Intercept	671.439 (-2.354)[a]	-4408.209 (-5.749)	-383.012 (-0.813)	694.356 (1.752)	-8781.273 (-2.530)	3530.291 (1.142)
Year	14.262 (3.709)	74.948 (5.424)	5.251 (0.651)	-5.203 (-0.921)	145.462 (3.762)	-27.086 (-0.816)
Picnicking	0.282 (2.037)	-0.391 (-1.228)	0.331 (2.371)	0.138 (1.338)	0.724 (0.645)	-0.793 (-1.138)
Intercept	-533.488 (-1.732)	-3923.471 (-2.797)	-113.524 (-0.211)	1520.362 (1.352)	-6277.435 (-3.165)	1921.814 (1.349)
Year	12.881 (2.965)	64.927 (2.796)	0.437 (0.046)	-18.506 (-0.931)	77.218 (2.139)	-52.677 (-1.345)
Camping	0.036 (1.252)	-0.015 (-0.247)	0.116 (2.486)	0.047 (0.755)	0.217 (2.475)	0.321 (1.621)
Intercept	-39.145 (-0.075)	-2298.028 (-2.851)	-2064.786 (-2.377)	1595.248 (1.686)	-4129.472 (-2.049)	1746.840 (0.548)
Year	5.184 (0.596)	38.558 (3.055)	34.665 (2.605)	-18.021 (-1.190)	81.611 (2.709)	-17.704 (-0.351)
Hiking and Mountain Climbing	25.941 (1.114)	6.238 (1.797)	-28.920 (-1.127)	7.426 (1.012)	19.111 (3.089)	4.004 (0.513)

[a]Values in parentheses are t values for H_o: B=0. Degrees of freedom for t = 8.

Table 1 (continued)

Coefficient	Region 1	Region 2	Region 3	Region 4	Region 5	Region 6
Intercept	-395.818	-4914.738	-1178.821	1899.554	-6508.953	223.593
	(-0.855)	(-6.531)	(-2.817)	(2.454)	(-2.377)	(0.195)
Year	11.793	80.650	20.453	-23.209	119.885	6.513
	(1.631)	(6.815)	(3.413)	(-1.870)	(2.835)	(0.354)
Winter sports	0.083	-0.131	0.215	0.254	0.291	0.017
	(0.315)	(-1.975)	(0.478)	(1.720)	(0.674)	(0.044)
Intercept	-56.984	-3592.887	-674.077	724.154	-9962.682	-907.281
	(-0.159)	(-8.332)	(-0.929)	(1.628)	(-3.356)	(-1.037)
Year	0.371	59.492	9.972	-4.059	203.139	4.299
	(0.047)	(8.914)	(0.709)	(-0.637)	(3.580)	(0.390)
National park use	0.135	0.004	0.027	0.004	-0.306	0.320
	(1.929)	(-0.044)	(0.859)	(0.112)	(-1.451)	(2.822)

substitution exists, it exists in both directions. Thus if the number of people substituting an alternate activity for wilderness is offset by the number of people substituting wilderness for the alternate activity, regression techniques will not reveal the existence of substitution.

Although substitution may exist between wilderness and other activities, no substitution was discernible using existing data. Consequently, no attempt was made to incorporate substitution into the models to be discussed in following chapters.

CHAPTER IV. MODEL DEVELOPMENT USING TIME-SERIES CROSS-SECTION REGRESSION

General

Ordinary least squares (OLS) regression is probably the most widely used form of regression analysis. Provided basic assumptions hold for the data being analyzed, OLS provides best linear unbiased estimates of regression coefficients in the model specified. Using this technique, a model of the form

$$Y_i = \sum_{k=1}^{p} \beta_k X_{ik} + \varepsilon_i, \; i = 1, 2 \ldots n$$

is hypothesized. Basic assumptions of the model are:

1) ε_i is a random variable with mean zero and variance σ^2, and
2) ε_i and ε_j are uncorrelated, $i \neq j$.

In this study, data for ten years for each of eight U.S. Forest Service regions were used in model development. While OLS will give an unbiased estimate of β when this combination of time-series and cross-section data is used, the OLS estimate of the variance of β is not unbiased (Fuller and Battese, 1974), and a modified form of regression analysis is required.

A more appropriate model for analysis of data consisting of N cross sections observed in each of T time periods is given by

$$Y_{ij} = \sum_{k=1}^{p} \beta_k X_{ijk} + u_{ij}, \; i = 1, \ldots N, \; j = 1, \ldots T$$

The random errors, u_{ij}, are assumed to be the sum of three components

$$u_{ij} = v_i + e_j + \varepsilon_{ij}$$

Further, the errors v_i, e_j, and ε_{ij} are independently distributed with zero means and variances $\sigma_v^2 \geq 0$, $\sigma_e^2 \geq 0$, and $\sigma_\varepsilon^2 > 0$ (Fuller and Battese, 1974).

Using this formulation and Generalized Least Squares regression analysis, a minimum variance unbiased linear estimator of β can be obtained

$$b = (X'V^{-1}X)^{-1}X'V^{-1}Y$$

with a variance-covariance matrix of

$$\mathrm{var}(b) = (X'V^{-1}X)^{-1}$$

where V is the estimator of the covariance matrix for the time-series cross-section model.

A computer program (Time-Series Cross-Section Regression) which uses this formulation is available through Statistical Analysis Systems (SAS Institute, 1977) and was used in developing the models presented in this chapter.

Model Development

Plots of residuals from models based on raw data indicated a need for transformation of variables to stabilize variance. Log_{10} transformations of all variables were therefore used. At least one study (Kalter and Gosse, 1969) indicates that log/log transformations give the best results for recreation use models.

Correlations with log wilderness use

Initially, each of the transformed variables was correlated with the log of wilderness use. Correlation coefficients for each variable are shown in Table 2. Only three variables, excluding the family income class variables, have correlation coefficients significantly different from zero above the 99 percent level. These three variables are regional wilderness acreage, past wilderness use within the region, and regional median family income. Of the family income class variables, only the coefficient for the $12,000 to $14,999 class is not significant above the 99 percent level.

Selection of variables

From a statistical standpoint, these variables would form a logical basis for model development. From an economic perspective, however, it may be desirable to consider other variables.

Intuitively, several factors would be expected to influence wilderness use. Certainly, if the supply of wilderness is limiting, the amount of wilderness use recorded should be less than if supply is not a limiting factor. Both regional wilderness acreage and national wilderness acreage give some measure of the supply of wilderness.

Demand for wilderness experience is a function of several variables. It seems plausible that as population within a region increases, the number of people who participate in wilderness recreation might also increase. Thus, regional population might serve as a proxy for wilderness

Table 2. Correlation of all variables with wilderness use

Variable	Wilderness use	Variable	Wilderness use	Variable	Wilderness use
Regional wilderness acreage[a]	0.81 (0.0001)[b]	% males <8[c]	-0.14 (0.2049)	% females 8	-0.14 (0.2053)
Regional population	-0.08 (0.4595)	% males 8	-0.14 (0.2142)	% females 9-11	-0.13 (0.2395)
National population	0.14 (0.2077)	% males 9-11	-0.14 (0.2309)	% females 12	0.14 (0.2287)
Past wilderness use	0.98 (0.0001)	% males 12	0.13 (0.2345)	% females 13-15	0.14 (0.2076)
National wilderness acreage	0.11 (0.3385)	% males 13-15	0.14 (0.2125)	% females 16	0.14 (0.2274)
Regional median family income	0.78 (0.0001)	% males 16	0.14 (0.2037)	% females >16	0.14 (0.2095)
Median male education	0.14 (0.2080)	% males >16	0.14 (0.2262)	Median male age	0.13 (0.2463)
Median female education	0.13 (0.2450)	% females <8	-0.14 (0.2046)	Median female age	0.11 (0.3177)

[a]All variables are $\log_{10}$ transformations.

[b]Probability of $>|r|$ under H_o: Rho = 0; n = 80.

[c]Numbers refer to years of education completed.

Table 2 (continued)

Variable	Wilderness use	Variable	Wilderness use	Variable	Wilderness use
% males 14-19[d]	0.09 (0.4130)	% females 20-24	0.13 (0.2657)	% with 5000-6999	-0.57 (0.0001)
% males 20-24	0.14 (0.2100)	% females 25-34	0.14 (0.2212)	% with 7000-9999	-0.75 (0.0001)
% males 25-34	0.14 (0.2204)	% females 35-44	-0.14 (0.2170)	% with 10,000-11,999	-0.29 (0.0082)
% males 35-44	0.01 (0.9502)	% females 45-54	-0.14 (0.2194)	% with 12,000-14,999	0.09 (0.4307)
% males 45-54	-0.14 (0.2085)	% females 55-64	-0.10 (0.3843)	% with 15,000-24,999	0.80 (0.0001)
% males 55-64	-0.14 (0.2168)	% females >65	0.14 (0.2063)	% with ≥25,000	0.66 (0.0001)
% males >65	-0.12 (0.2844)	% with <3000[e]	-0.81 (0.0001)		
% females 14-19	0.06 (0.5848)	% with 3000-4999	-0.74 (0.0001)		

[d]Numbers refer to age classes.

[e]Numbers refer to family income classes in 1975 dollars.

demand. Lucas (1970) indicates that wilderness users generally do not travel long distances to reach wilderness areas, thus regional population should account for much of the demand in this form. To account for demand from outside the area, national population might serve as a proxy variable.

Median family income has been shown to be correlated with wilderness use and would be expected to have an effect on demand for wilderness, that is as income increases, demand would also be expected to increase.

Finally, several wilderness studies cited in Chapter Two indicate that a majority of wilderness users report above average education, and age in the twenties to early thirties. For this reason, it seems reasonable to include median education and median age variables in initial model development. Since most wilderness users are male, male education and age variables were used.

Wilderness use during the previous year is highly correlated with present wilderness use as would be expected, but its inclusion in a model using time-series cross-section regression introduces problems of multicollinearity and thus, development of a lagged-use model with appropriate adjustments is delayed until the following chapter.

The variables selected for model development using time-series cross-section regression are: present wilderness use within each region (dependent variable), regional wilderness acreage, national wilderness acreage, regional population, national population, regional median family income, national median male age, and national median male education. Table 3 shows the correlation matrix for these eight variables.

Table 3. Correlation matrix for variables used in model development

	Use	Regional acreage	National acreage	Regional population	National population	Median family income	Median male age	Median male education
Use[a]	1.00 (0.0000)[b]							
Regional wilderness acreage	0.80 (0.0001)	1.00 (0.0000)						
National wilderness acreage	0.11 (0.3385)	0.04 (0.7066)	1.00 (0.0000)					
Regional population	-0.08 (0.4595)	-0.60 (0.0001)	0.02 (0.8273)	1.00 (0.0000)				
National population	0.14 (0.2077)	0.04 (0.7432)	0.79 (0.0001)	0.03 (0.8004)	1.00 (0.0000)			
Median family income	0.78 (0.0001)	0.85 (0.0001)	0.18 (0.1011)	-0.38 (0.0005)	0.31 (0.0053)	1.00 (0.0000)		
Median male age	0.13 (0.2463)	0.04 (0.6947)	0.94 (0.0001)	0.03 (0.8057)	0.92 (0.0001)	0.21 (0.0641)	1.00 (0.0000)	
Median male education	0.14 (0.2080)	0.04 (0.7189)	0.82 (0.0001)	0.03 (0.8027)	0.99 (0.0001)	0.30 (0.0066)	0.91 (0.0001)	1.00 (0.0000)

[a]All variables are $\log_{10}$ transformations.

[b]Probability of $>|r|$ under H_o: Rho = 0; n = 80.

Model testing

Based on the assumption concerning factors affecting supply and demand, the initial model tested was of the form

$$LWU = \beta_0 + \beta_1 LWA + \beta_2 LNWA + \beta_3 LPOP + \beta_4 LNPOP + \beta_5 LMFI + \beta_6 LMMA + \beta_7 LMME$$

where LWU = $\log_{10}$ (wilderness use).

LWA = $\log_{10}$ (regional wilderness acreage)

LNWA = $\log_{10}$ (national wilderness acreage)

LPOP = $\log_{10}$ (regional population)

LNPOP = $\log_{10}$ (national population)

LMFI = $\log_{10}$ (regional median family income)

LMMA = $\log_{10}$ (national median male age)

LMME = $\log_{10}$ (national median male education)

Results of the regression are shown in Table 4.

It should be noted that the standard errors for the coefficients associated with national wilderness acreage and national population are relatively large compared to the coefficients. This would seem to indicate that wilderness acreage within a region may be sufficient to account for wilderness supply, and that demand for wilderness from people outside the region is not significant when using this model formulation. To test the hypothesis that $b_2 = b_4 = 0$, an F test was calculated and found not significant at the 95 percent level (calculated $F^{2}_{72} = 2.538$). Based on this test, national wilderness acreage and national population were dropped from the model and a second regression was run. Coefficients and standard errors are shown in Table 5.

Table 4. Results of the seven variable model using time-series cross-section regression with variance component estimates

Source		b value	Standard error	t for $H_o:\beta=0$	Prob.>|t|
Intercept	(b_0)	-8.1233	45.2800	-0.1794	0.8581
LWA	(b_1)	-0.8468	0.0833	10.1610	0.0001
LNWA	(b_2)	-3.3295	2.5600	-1.3006	0.1976
LPOP	(b_3)	0.4560	0.1213	3.7593	0.0003
LNPOP	(b_4)	1.5407	6.4135	0.2402	0.8108
LMFI	(b_5)	1.1368	0.8149	1.3952	0.1673
LMMA	(b_6)	6.5166	8.6973	0.2039	0.3390
LMME	(b_7)	2.2492	11.0280	0.7493	0.4561
	Variance component for cross sections			0.04135	
	Variance component for time series			0.0	
	Variance component for error			0.00489	

Table 5. Results of the five variable model using time-series cross-section regression with variance component estimates

Source		b value	Standard error	t for $H_o:\beta=0$	Prob.>|t|
Intercept	(b_0)	-13.6680	2.9211	-4.6791	0.0001
LWA	(b_1)	0.8387	0.0803	10.4410	0.0001
LPOP	(b_2)	0.4601	0.1160	3.9663	0.0002
LMFI	(b_3)	1.2918	0.7655	1.6875	0.0957
LMMA	(b_4)	-0.9196	3.9431	-0.2332	0.3162
LMME	(b_5)	6.4490	5.3758	1.1996	0.2341
	Variance component for cross sections			0.03629	
	Variance component for time series			0.00029	
	Variance component for error			0.00508	

As indicated by the standard errors, all coefficients in this model were improved over those in the previous model. The standard error for median male age, however, is still quite large in relation to the coefficient, and as expected, a test of the hypothesis that $b_4 = 0$ is not significant at the 95 percent level (calculated $F^1_{74} = 0.054$). This result should not necessarily be interpreted to mean that age has no effect on wilderness use but rather that the data do not yield a statistically significant regression coefficient. Because of this, median male age was dropped from the equation and wilderness use was regressed on the remaining four variables. Table 6 shows the results of that regression.

Table 6. Results of the four variable regression using time-series cross-section regression with variance component estimates

Source		b values	Standard error	t for H_o:β=0	Prob.>|t|
Intercept	(b_0)	-13.8999	2.3565	-5.8985	0.0001
LWA	(b_1)	0.8364	0.0785	10.6560	0.0001
LPOP	(b_2)	0.4586	0.1159	3.9574	0.0002
LMFI	(b_3)	1.3072	0.6676	1.9581	0.0539
LMME	(b_4)	5.4156	2.1658	2.5005	0.0146
	Variance component for cross sections			0.03629	
	Variance component for time series			0.00017	
	Variance component for error			0.00508	

Again, an improvement in the coefficients is evidenced by the decrease in size of all standard error values. All coefficients for the model are significantly different from zero at the 95 percent level with the exception of median male education which is significant at the 94 percent level.

Predicted vs. actual use using the four variable model

When time-series cross-section regression is used, regional effects are treated as random. This treatment causes predictions for some regions to be consistently high while others are consistently low. Figures 3 through 10 show this phenomenon with Figure 5 showing an extreme case of over projection and Figure 7 showing an extreme case of under projection. When evaluating national trends in use, however, this is not a problem since accumulation of yearly totals across regions results in a correct projection of national use as is apparent in Figure 11.

To make regional wilderness use projections with this model, the regional effect should be treated as fixed rather than random. Adjustments can be made in the model to allow for regional projections by determining the average residual across years for each region. These averages are then incorporated into the intercept term to yield a unique intercept for each region. Once this is done, projections can be made for individual regions. Table 7 shows the average residual and adjusted intercept that should be used for each region.

To give an indication of the amount of variation in national wilderness use explained by the unadjusted model, an adjusted R^2 can be used. Since the computer program used to develop this model does not calculate R^2 values, it was necessary to correlate predicted wilderness use values with actual values to obtain the simple correlation between the two. As indicated by Kalter and Gosse (1969),

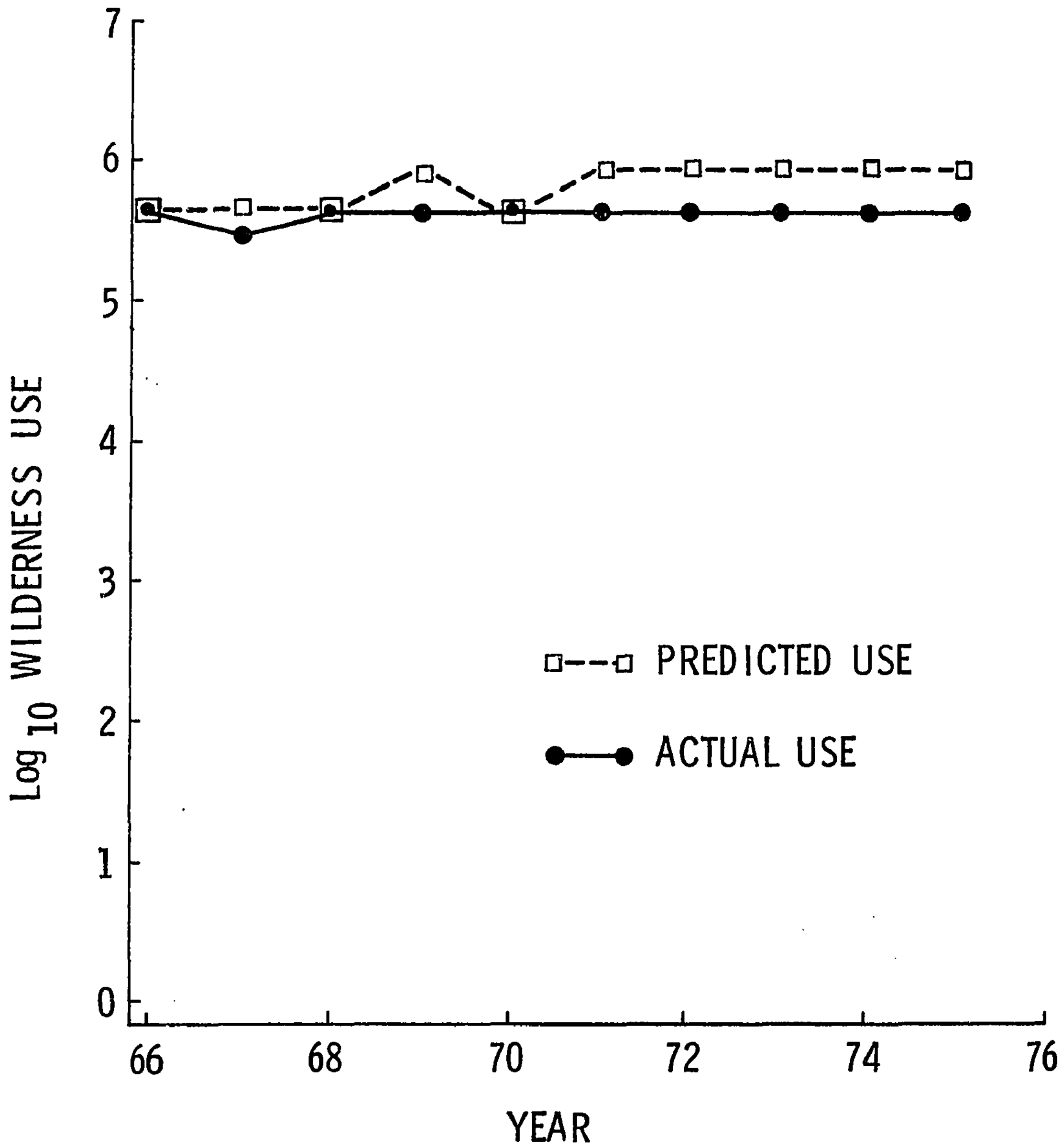


Figure 3. Region 1 predicted national use component and actual use for 1966 through 1975 using the model $LWU = \beta_0 + \beta_1 LWA + \beta_2 LPOP + \beta_3 LMFI + \beta_4 LMME$

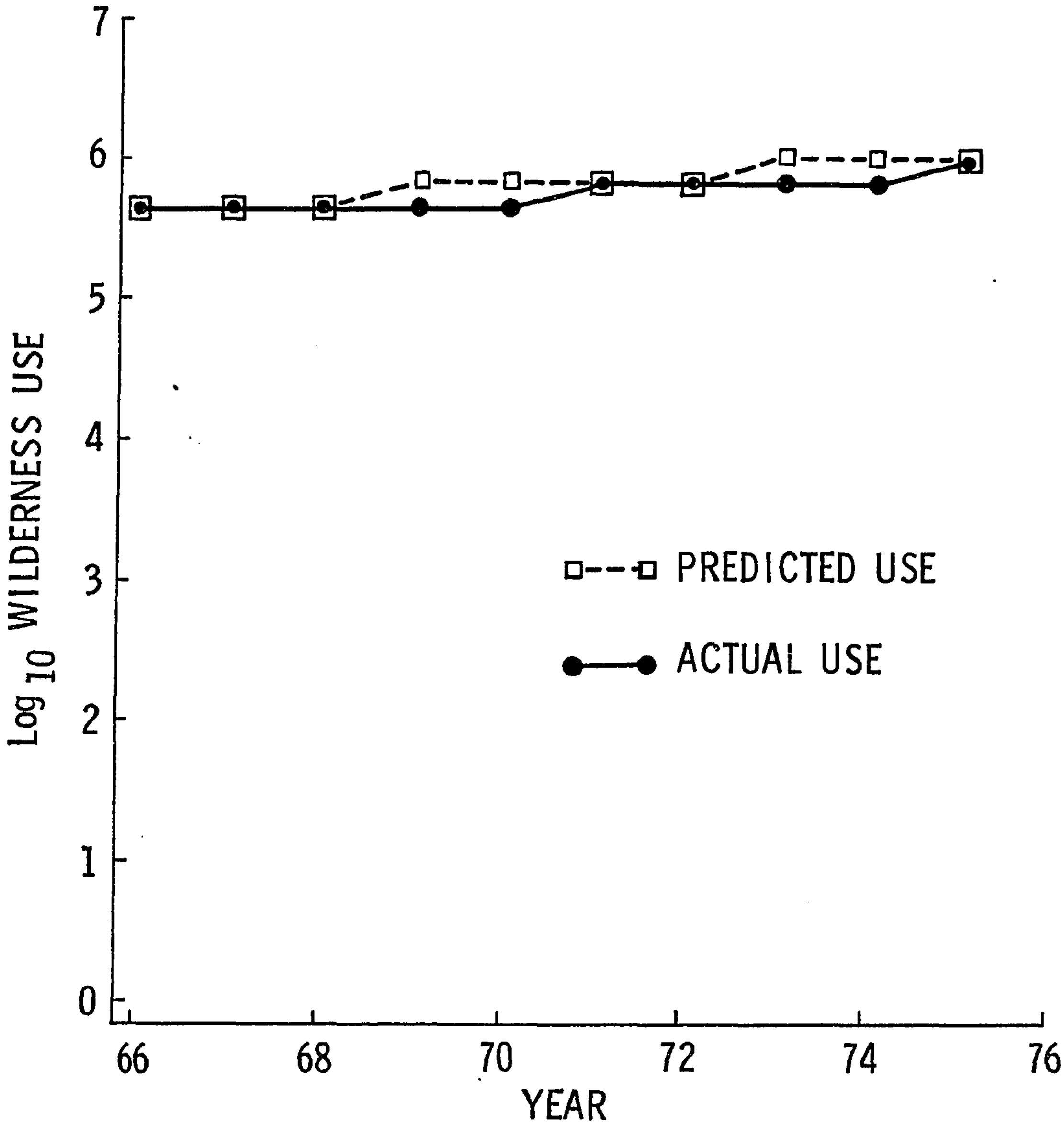


Figure 4. Region 2 predicted national use component and actual use for 1966 through 1975 using the model $LWU = \beta_0 + \beta_1 LWA + \beta_2 LPOP + \beta_3 LMFI + \beta_4 LMME$

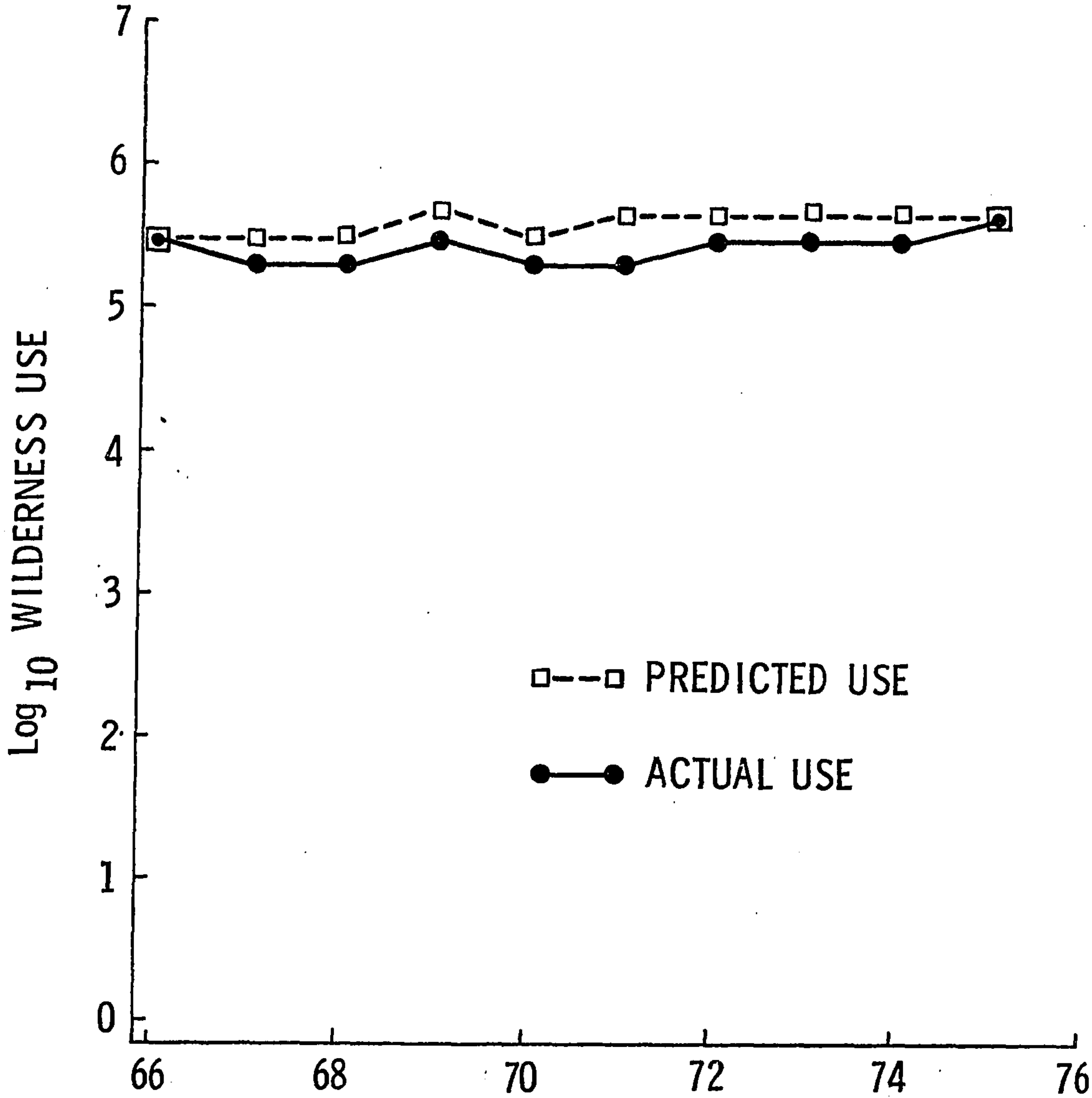


Figure 5. Region 3 predicted national use component and actual use for 1966 through 1975 using the model $LWU = \beta_0 + \beta_1 LWA + \beta_2 LPOP + \beta_3 LMFI + \beta_4 LMME$

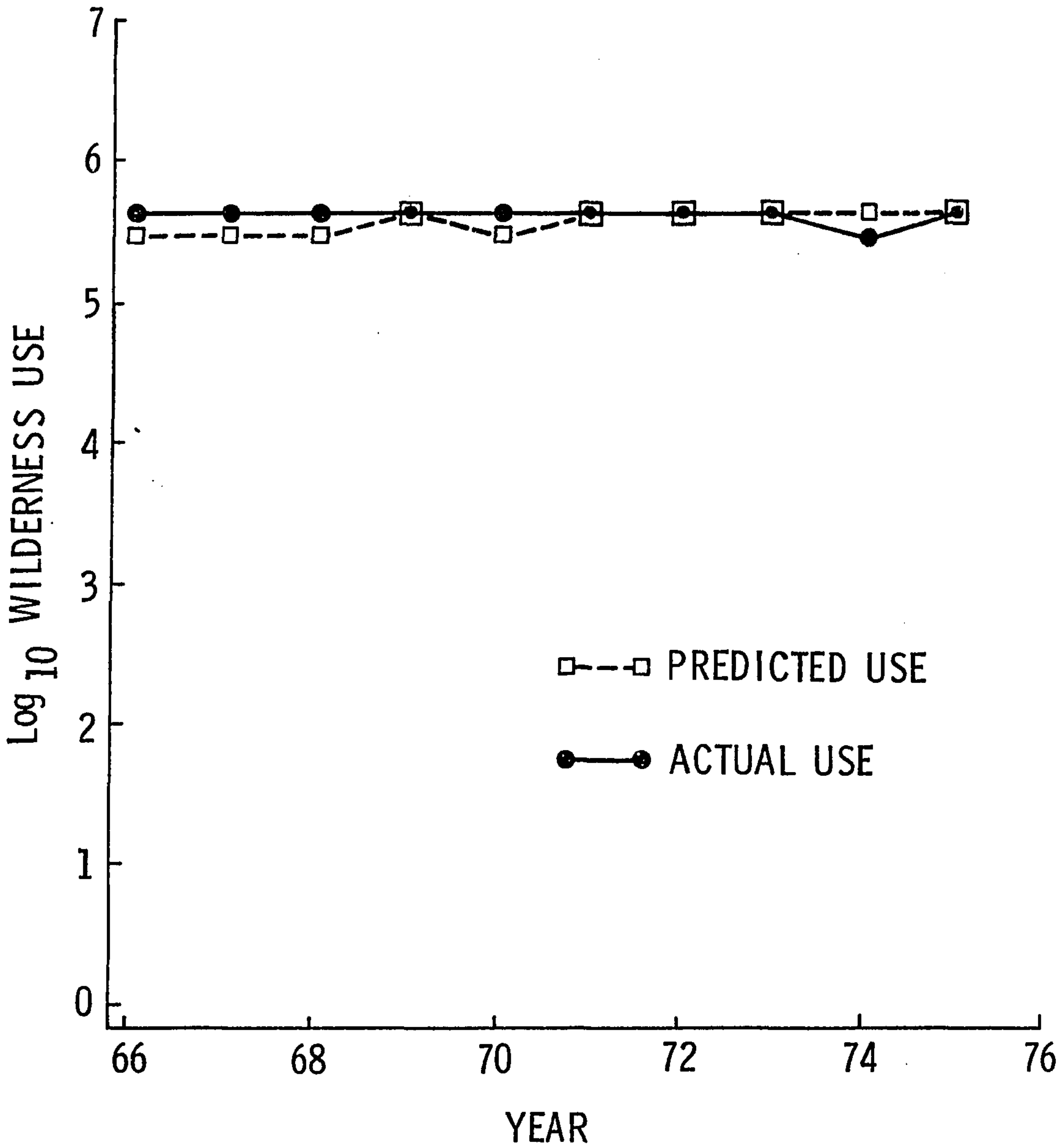


Figure 6. Region 4 predicted national use component and actual use for 1966 through 1975 using the model $LWU = \beta_0 + \beta_1 LWA + \beta_2 LPOP + \beta_3 LMFI + \beta_4 LMME$

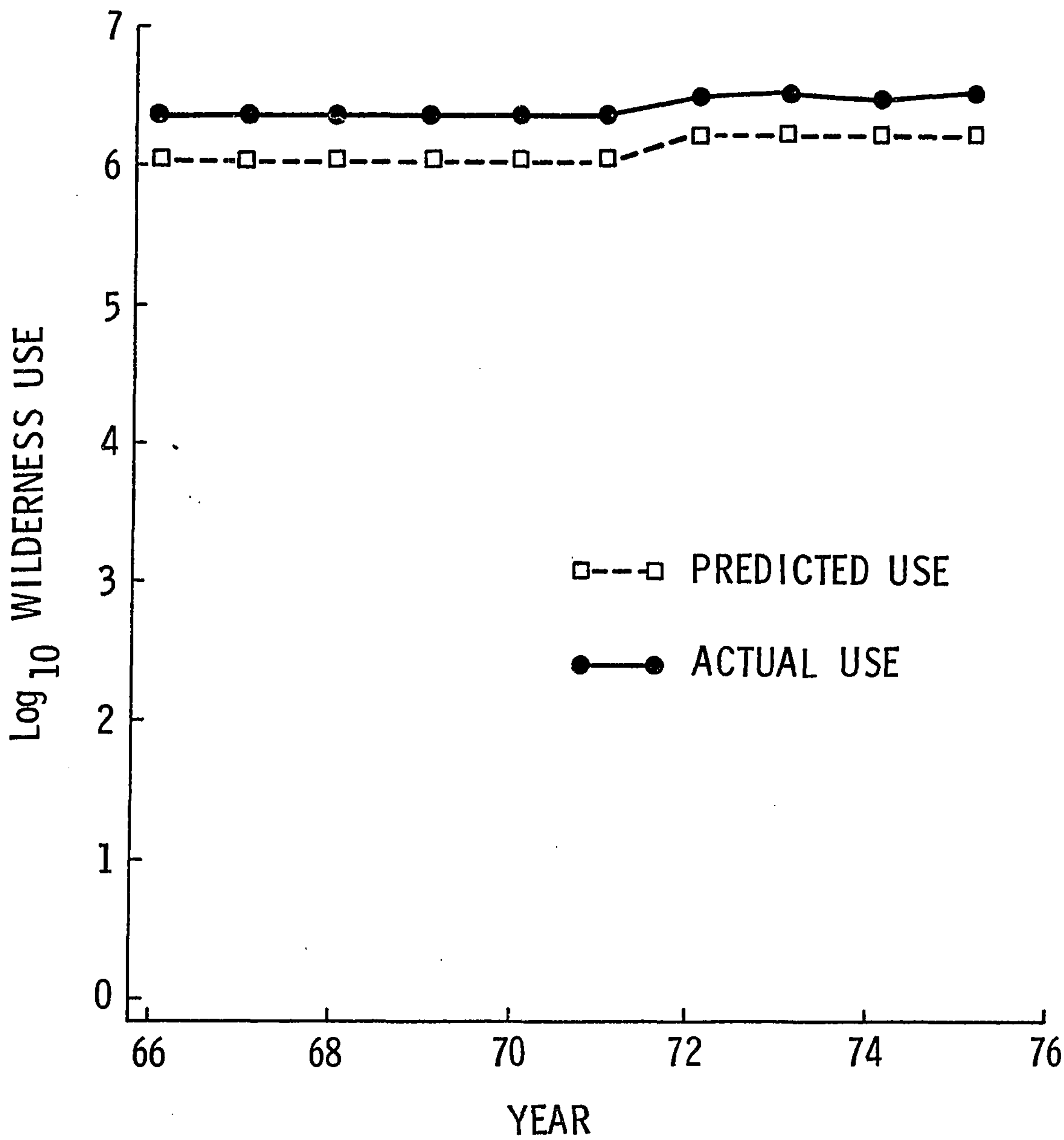


Figure 7. Region 5 predicted national use component and actual use for 1966 through 1975 using the model $LWU = \beta_0 + \beta_1 LWA + \beta_2 LPOP + \beta_3 LMFI + \beta_4 LMME$

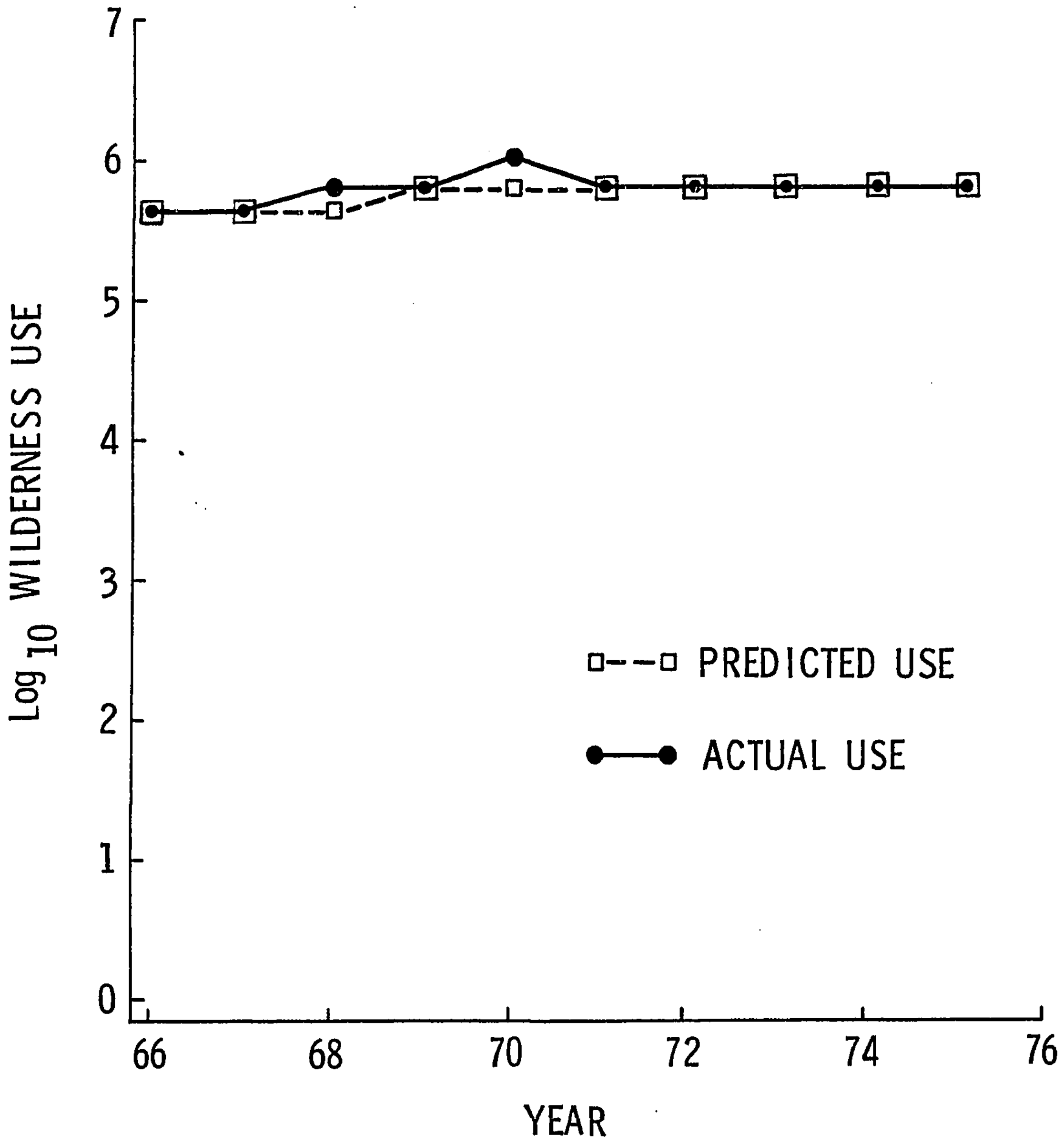


Figure 8. Region 6 predicted national use component and actual use for 1966 through 1975 using the model $LWU = \beta_0 + \beta_1 LWA + \beta_2 LPOP + \beta_3 LMFI + \beta_4 LMME$

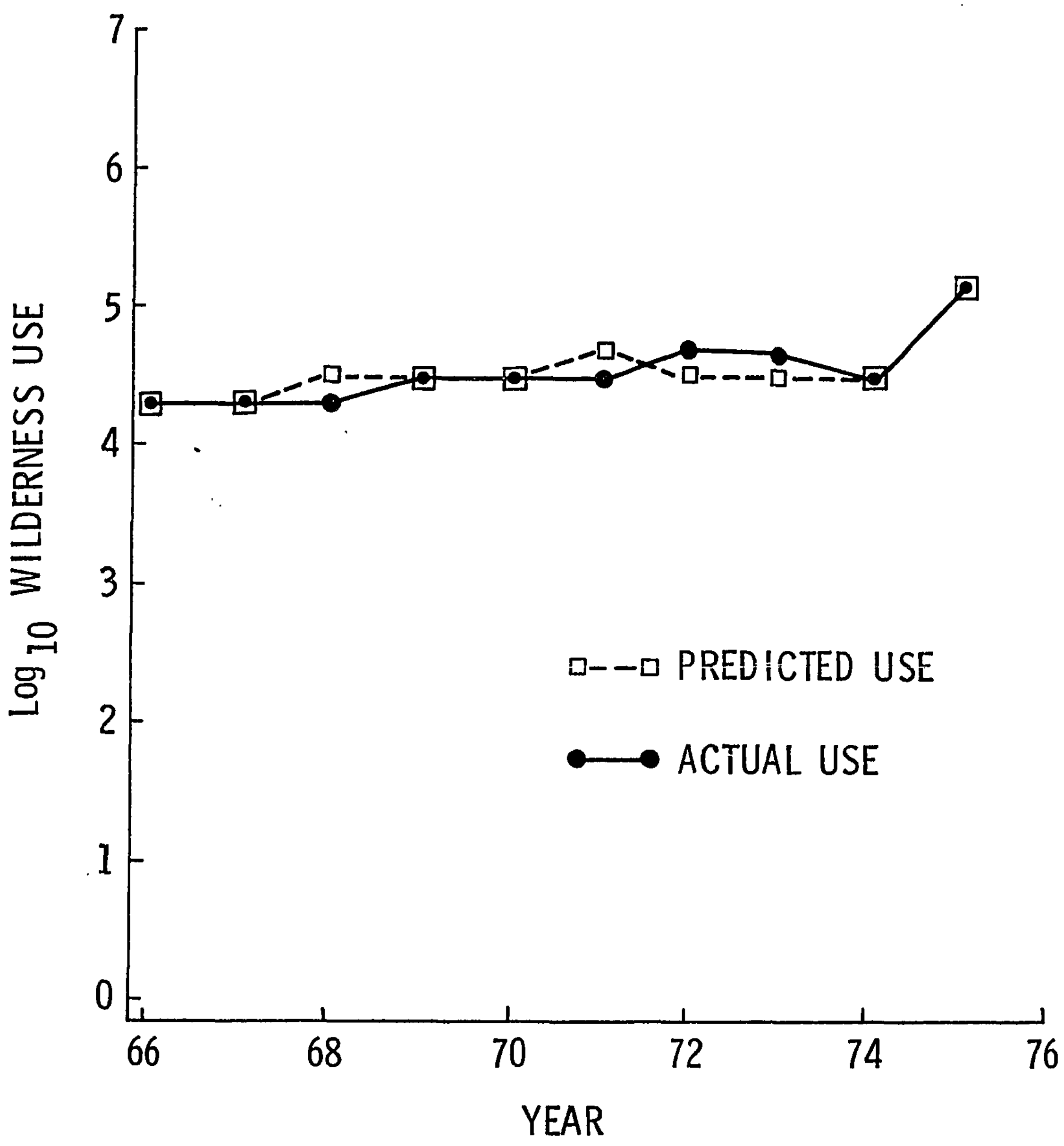


Figure 9. Region 8 predicted national use component and actual use for 1966 through 1975 using the model $LWU = \beta_0 + \beta_1 LWA + \beta_2 LPOP + \beta_3 LMFI + \beta_4 LMME$

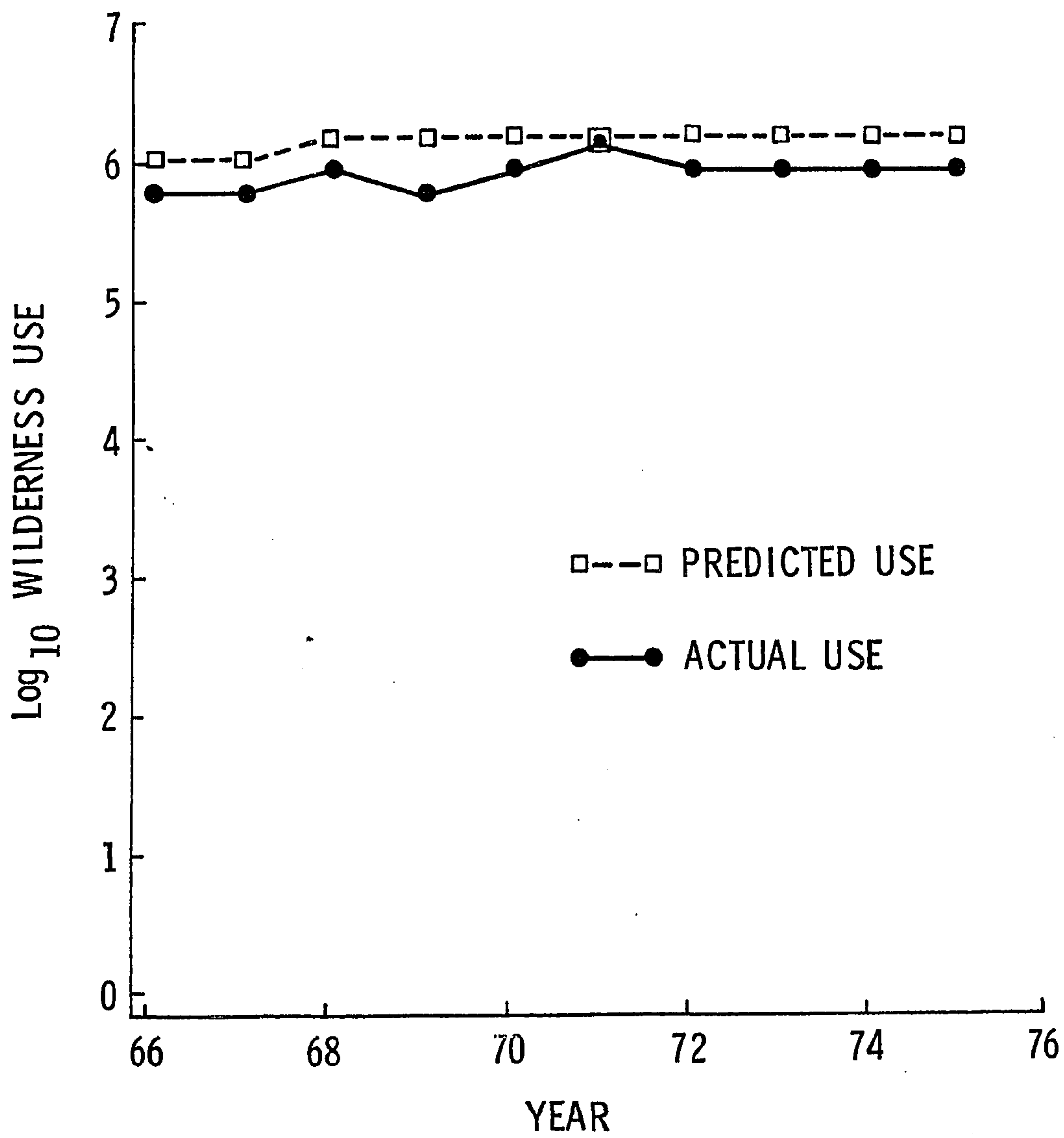


Figure 10. Region 9 predicted national use component and actual use for 1966 through 1975 using the model $LWU = \beta_0 + \beta_1 LWA + \beta_2 LPOP + \beta_3 LMFI + \beta_4 LMME$

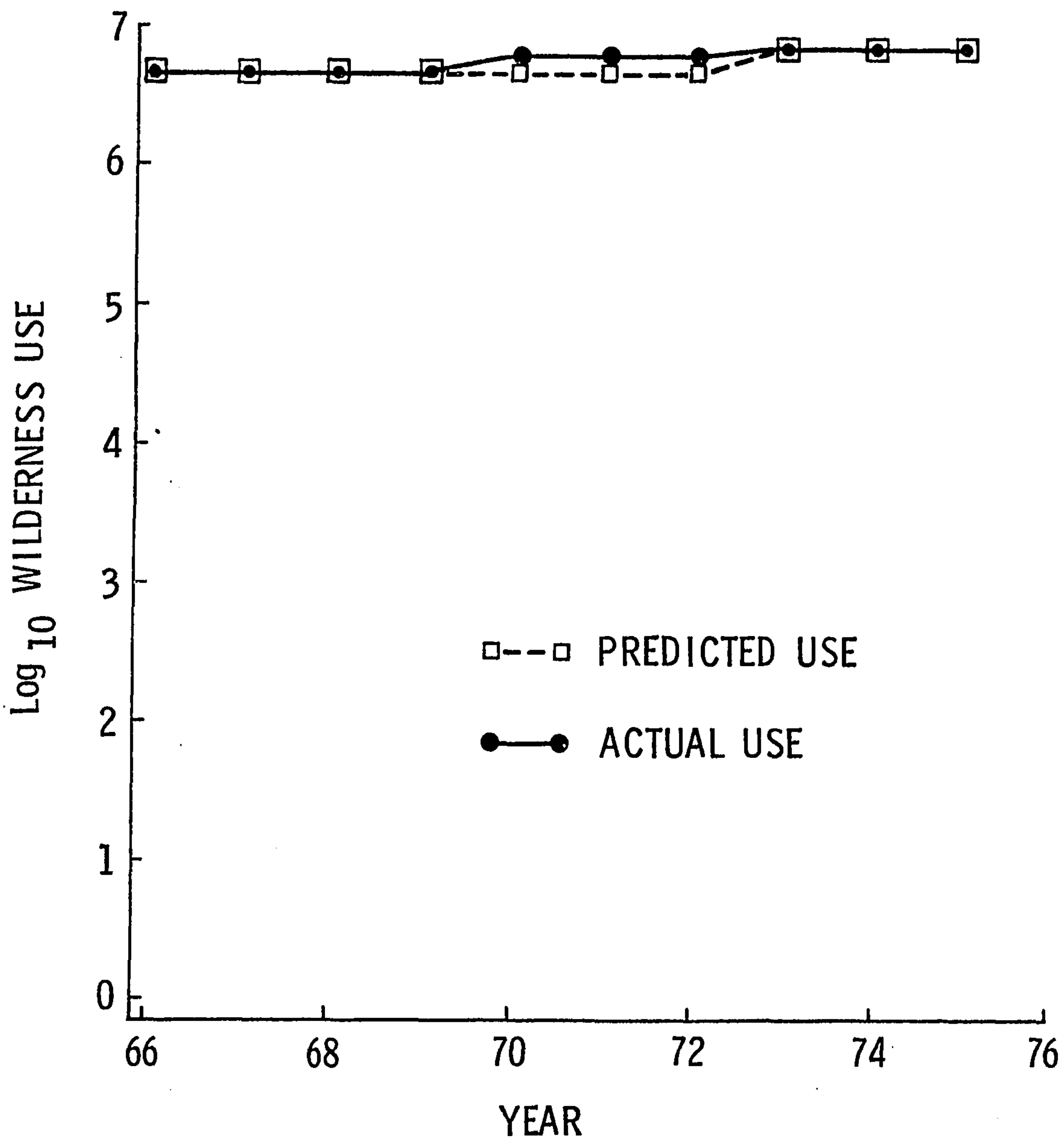


Figure 11. National total predicted and actual use for 1966 through 1975 using the model $LWU = \beta_0 + \beta_1 LWA + \beta_2 LPOP + \beta_3 LMFI + \beta_4 LMME$

Table 7. Regional average residuals and adjusted intercepts for the four variable model

Region	Average residual	Adjusted intercept
1	-0.1010	-14.0009
2	-0.0364	-13.9363
3	-0.1576	-14.0575
4	0.0691	-13.8308
5	0.3128	-13.5871
6	0.0686	-13.8313
8	-0.0022	-13.9021
9	-0.1543	-13.0542

"R^2 may be thought of as the square of the simple correlation coefficient between the observed values of the dependent variable and the values that are calculated using the observed values of the independent variables in the estimated regression equation. The adjusted R^2 or $\bar{R}^2$ is defined as:

$$\bar{R}^2=1-\left[(1-R^2)(T-1)/(T-K-1)\right]$$

where T = the number of observations in the sample, and
K = the number of independent variables in the equation.

This computation penalizes an equation for having a large number of independent variables relative to the number of observations. Thus, it is useful in deciding whether the addition of a variable has increased substantially the predictive power of the equation. As the number of observations increase, the value of $\bar{R}^2$ approaches that of R^2."

To obtain an $\bar{R}^2$ for the national total, the sums of actual use and predicted use across regions were calculated for each year. These totals were then correlated and adjusted to obtain a national $\bar{R}^2$. The unadjusted R^2 for predicted national wilderness use is 0.82 while $\bar{R}^2$ for the model is 0.81

Projections

Assumptions concerning independent variables

In order to make projections, it is necessary to have estimates of the four independent variables for the projection. Regional population estimates were obtained by adding state population estimates for states within a region from the Obers projections (U.S. Department of Commerce, 1972). Estimates of median male education are based on Bureau of Census information and correspond to educational attainment estimates used in the study which estimates outdoor recreation demand for the 1980 Resource Planning Act assessment (Hof, 1978).

Estimates of median family income for the projection years were not available so the trend from 1966 through 1975 was used to project median family income for the desired years. Estimates for median family income are in 1975 dollars.

While only one set of values for population, education, and income was used, three scenarios of wilderness acreage increase were used in making projections. The first scenario assumed no increase in wilderness acreage beyond that presently in the system. The remaining scenarios are based on alternative D as described in the RARE II report (U.S. Department of Agriculture, 1978). If alternative D is selected, it will result in an addition of approximately 12 million acres to the wilderness system and will meet the Forest Service goal of 25-30 million acres of wilderness by 2020.

Scenario II assumes that wilderness acreage will remain constant at the present level until 1985, and that by 1990 all of the acreage recommended for wilderness under alternative D will have been added to the present system. After 1990, acreage is assumed to remain constant at approximately 27 million acres.

Scenario III also assumes constant acreage until 1985. Between 1985 and 1990 it is assumed that 50 percent of the acreage recommended for wilderness in each region under alternative D will be added bringing the national system to approximately 21 million acres. An increase of 25 percent of the recommended acreage is assumed between 1990 and 2000, with a final increase between 2010 and 2020 to incorporate the remainder of the recommended acreage. The final acreage included under scenario III will be approximately 27 million acres as was the case for scenario II. Table 8 shows values of independent variables for projection years.

Regional component of national wilderness use projections

Using the model

$$LWU = -13.8999 + .8364(LWA) + .4586(LPOP) + 1.3072(LMFI) + 5.4156(LMME)$$

projections of wilderness use were made for 1980, 1985, 1990, 2000, 2010, and 2020 for each of the acreage increase scenarios discussed previously. Tables 9 through 16 show the projection of $\log_{10}$ wilderness use for each region. Standard error of the projection and conversion to number of visitor days is shown for each projection. It should be noted that

Table 8. Values of independent variables for projection years

	1980	1985	1990	2000	2010	2020
			Region 1			
Acreage						
I[a]	3,646,948			No increase		
II	3,646,948	3,646,948	5,068,125		No increase	
III	3,646,948	3,646,948	4,357,536	4,712,830	4,712,830	5,068,125
Population (1000)	1,720	1,754	1,789	1,895	2,042	2,209
Family Income (1975 $)	14,744	15,171	15,599	16,455	17,310	18,165
Education	12.5	12.6	12.7	12.9	13.1	13.3
			Region 2			
Acreage						
I	2,365,897			No increase		
II	2,365,897	2,365,897	2,768,253		No increase	
III	2,365,897	2,365,897	2,567,075	2,667,664	2,667,664	2,768,253
Population (1000)	7,591	8,036	8,481	9,466	10,670	12,030
Family Income (1975 $)	14,744	15,171	15,599	16,455	17,310	18,165
Education	12.5	12.6	12.7	12.9	13.1	13.3

[a]Numbers indicate scenarios of wilderness acreage increase.

Table 8 (continued)

	1980	1985	1990	2000	2010	2020
			Region 3			
Acreage						
I	1,657,796			No increase		
II	1,657,796	1,657,796	2,281,686		No increase	
III	1,657,796	1,657,796	1,969,741	2,125,714	2,125,714	2,281,686
Population (1000)	3,800	3,623	3,446	4,399	4,956	5,536
Family Income (1975 $)	14,744	15,171	15,599	16,455	17,310	18,165
Education	12.5	12.6	12.7	12.9	13.1	13.3
			Region 4			
Acreage						
I	2,058,969			No increase		
II	2,058,969	2,058,969	4,076,207		No increase	
III	2,058,969	2,058,969	3,067,588	3,571,898	3,571,898	4,076,207
Population (1000)	2,269	2,492	2,715	3,172	3,732	4,381
Family Income (1975 $)	14,744	15,171	15,599	16,455	17,310	18,165
Education	12.5	12.6	12.7	12.9	13.1	13.3

Table 8 (continued)

	1980	1985	1990	2000	2010	2020
				Region 5		
Acreage						
I	2,055,164			No increase		
II	2,055,164	2,055,164	2,483,184		No increase	
III	2,055,164	2,055,164	2,269,174	2,376,181	2,376,181	2,483,184
Population (1000)	24,166	26,704	29,241	34,298	40,174	46,829
Family Income (1975 $)	14,744	15,171	15,599	16,455	17,310	18,165
Education	12.5	12.6	12.7	12.9	13.1	13.3
				Region 6		
Acreage						
I	1,923,972			No increase		
II	1,923,972	1,923,972	2,598,838		No increase	
III	1,923,972	1,923,972	2,261,405	2,430,121	2,430,121	2,598,838
Population (1000)	6,350	6,831	7,311	8,278	9,395	10,635
Family Income (1975 $)	14,744	15,171	15,599	16,455	17,310	18,165
Education	12.5	12.6	12.7	12.9	13.1	13.3

Table 8 (continued)

	1980	1985	1990	2000	2010	2020
			Region 8			
Acreage						
I	127,918	------	------	No increase	------	------
II	127,918	127,918	509,531	------	No increase	------
III	127,918	127,918	318,724	414,127	414,127	509,531
Population (1000)	63,675	68,439	73,202	83,645	96,104	110,403
Family Income (1975 $)	12,761	13,286	13,811	14,861	159,911	16,961
Education	12.5	12.6	12.7	12.9	13.1	13.3
			Region 9			
Acreage						
I	1,112,804	------	------	No increase	------	------
II	1,112,804	1,112,804	1,348,368	------	No increase	------
III	1,112,804	1,112,804	1,230,586	1,289,477	1,289,477	1,348,368
Population (1000)	123,394	132,761	142,127	159,973	181,138	286,439
Family Income (1975 $)	15,180	15,879	16,578	17,975	19,372	20,770
Education	12.5	12.6	12.7	12.9	13.1	13.3

Table 9. Region 1 unadjusted component of national wilderness use assuming three scenarios of wilderness area increase

Year	Scenario I	Scenario II	Scenario III
1980	5.738[a] (0.077)[b] 547[c]	5.738 (0.077) 547	5.738 (0.077) 547
1985	5.777 (0.078) 598	5.777 (0.078) 598	5.777 (0.078) 598
1990	5.815 (0.080) 653	5.935 (0.080) 861	5.880 (0.080) 759
2000	5.894 (0.085) 783	6.013 (0.084) 1,030	5.987 (0.084) 971
2010	5.974 (0.092) 942	6.093 (0.091) 1,239	6.067 (0.091) 1,167
2020	6.052 (0.100) 1,127	6.172 (0.099) 1,486	6.172 (0.099) 1,486

[a] $LWU=\beta_0 + \beta_1 LWA + \beta_2 LPOP + \beta_3 LMFI + \beta_4 LMME$.

[b] Standard error of estimated LWU.

[c] Projected visitor days (in thousands).

Table 10. Region 2 unadjusted component of national wilderness use assuming three scenarios of wilderness area increase

Year	Scenario I	Scenario II	Scenario III
1980	5.940[a] (0.077)[b] 871[c]	5.940 (0.077) 871	5.940 (0.077) 871
1985	5.987 (0.078) 971	5.987 (0.078) 971	5.987 (0.078) 971
1990	6.032 (0.080) 1,076	6.089 (0.080) 1,227	6.061 (0.080) 1,151
2000	6.121 (0.085) 1,321	6.178 (0.085) 1,507	6.164 (0.085) 1,459
2010	6.209 (0.092) 1,618	6.267 (0.092) 1,849	6.253 (0.092) 1,791
2020	6.296 (0.100) 1,977	6.353 (0.100) 2,254	6.353 (0.100) 2,254

[a] $LWU = \beta_0 + \beta_1 LWA + \beta_2 LPOP + \beta_3 LMFI + \beta_4 LMME$.

[b] Standard error of estimated LWU.

[c] Projected visitor days (in thousands).

Table 11. Region 3 unadjusted component of national wilderness use assuming three scenarios of wilderness area increase

Year	Scenario I	Scenario II	Scenario III
1980	5.554[a] (0.077)[b] 358[c]	5.554 (0.077) 358	5.544 (0.077) 358
1985	5.579 (0.078) 379	5.579 (0.078) 379	5.579 (0.078) 379
1990	5.604 (0.080) 402	5.720 (0.080) 525	5.666 (0.079) 463
2000	5.719 (0.085) 524	5.835 (0.085) 684	5.810 (0.085) 646
2010	5.808 (0.093) 643	5.924 (0.092) 839	5.900 (0.092) 794
2020	5.893 (0.101) 782	6.009 (0.100) 1,021	6.009 (0.100) 1,021

[a] $LWU = \beta_0 + \beta_1 LWA + \beta_2 LPOP + \beta_3 LMFI + \beta_4 LMME$.

[b] Standard error of estimated LWU.

[c] Projected visitor days (in thousands).

Table 12. Region 4 unadjusted component of national wilderness use assuming three scenarios of wilderness area increase

Year	Scenario I	Scenario II	Scenario III
1980	5.753[a] (0.077)[b] 566[c]	5.753 (0.077) 566	5.753 (0.077) 566
1985	5.807 (0.078) 641	5.807 (0.078) 641	5.807 (0.078) 641
1990	5.858 (0.080) 721	6.106 (0.082) 1,276	6.003 (0.081) 1,007
2000	5.957 (0.086) 906	6.205 (0.089) 1,603	6.157 (0.087) 1,435
2010	6.054 (0.093) 1,132	6.302 (0.095) 2,004	6.254 (0.094) 1,795
2020	6.149 (0.102) 1,409	6.397 (0.103) 2,495	6.397 (0.103) 2,495

[a] $LWU=\beta_0 + \beta_1 LWA + \beta_2 LPOP + \beta_3 LMFI + \beta_4 LMME$.

[b] Standard error of estimated LWU.

[c] Projected visitor days (in thousands).

Table 13. Region 5 unadjusted component of national wilderness use assuming three scenarios of wilderness area increase

Year	Scenario I	Scenario II	Scenario III
1980	6.464[a] (0.077)[b] 2,911[c]	6.464 (0.077) 2,911	6.464 (0.077) 2,911
1985	6.520 (0.078) 3,311	6.520 (0.078) 3,311	6.520 (0.078) 3,311
1990	6.572 (0.080) 3,733	6.640 (0.081) 4,365	6.608 (0.080) 4,055
2000	6.670 (0.087) 4,677	6.739 (0.087) 5,483	6.723 (0.087) 5,284
2010	6.767 (0.094) 5,848	6.836 (0.094) 6,855	6.820 (0.094) 6,607
2020	6.860 (0.103) 7,244	6.929 (0.103) 8,492	6.929 (0.103) 8,492

[a] $LWU=\beta_0 + \beta_1 LWA + \beta_2 LPOP + \beta_3 LMFI + \beta_4 LMME$.

[b] Standard error of estimated LWU.

[c] Projected visitor days (in thousands).

Table 14. Region 6 unadjusted component of national wilderness use assuming three scenarios of wilderness area increase

Year	Scenario I	Scenario II	Scenario III
1980	5.933[a] (0.077)[b] 857[c]	5.933 (0.077) 857	5.933 (0.077) 857
1985	5.983 (0.078) 962	5.983 (0.078) 962	5.983 (0.078) 962
1990	6.031 (0.080) 1,074	6.140 (0.080) 1,380	6.089 (0.080) 1,227
2000	6.122 (0.085) 1,324	6.232 (0.085) 1,706	6.207 (0.085) 1,611
2010	6.213 (0.093) 1,633	6.322 (0.093) 2,099	6.297 (0.092) 1,985
2020	6.300 (0.101) 1,995	6.410 (0.101) 2,570	6.410 (0.101) 2,570

[a] $LWU = \beta_0 + \beta_1 LWA + \beta_2 LPOP + \beta_3 LMFI + \beta_4 LMME$.

[b] Standard error of estimated LWU.

[c] Projected visitor days (in thousands).

Table 15. Region 8 unadjusted component of national wilderness use assuming three scenarios of wilderness area increase

Year	Scenario I	Scenario II	Scenario III
1980	5.256[a] (0.092)[b] 180[c]	5.256 (0.092) 180	5.256 (0.092) 180
1985	5.312 (0.093) 205	5.312 (0.093) 205	5.312 (0.093) 205
1990	5.366 (0.096) 232	5.868 (0.126) 738	5.697 (0.114) 498
2000	5.471 (0.103) 296	5.973 (0.130) 940	5.897 (0.126) 789
2010	5.573 (0.112) 374	6.075 (0.137) 1,189	6.000 (0.132) 1,000
2020	5.673 (0.122) 471	6.175 (0.145) 1,496	6.175 (0.145) 1,496

[a] $LWU=\beta_0 + \beta_1 LWA + \beta_2 LPOP + \beta_3 LMFI + \beta_4 LMME$.

[b] Standard error of estimated LWU.

[c] Projected visitor days (in thousands).

Table 16. Region 9 unadjusted component of national wilderness use assuming three scenarios of wilderness area increase

Year	Scenario I	Scenario II	Scenario III
1980	6.122[a] (0.077)[b] 1,324[c]	6.122 (0.077) 1,324	6.122 (0.077) 1,324
1985	6.181 (0.078) 1,517	6.181 (0.078) 1,517	6.181 (0.078) 1,517
1990	6.217 (0.082) 1,648	6.287 (0.082) 1,936	6.254 (0.082) 1,795
2000	6.344 (0.092) 2,208	6.413 (0.092) 2,588	6.397 (0.092) 2,495
2010	6.447 (0.104) 2,799	6.517 (0.103) 3,289	6.501 (0.103) 3,170
2020	6.550 (0.116) 3,548	6.620 (0.116) 4,169	6.620 (0.116) 4,169

[a] $LWU=\beta_0 + \beta_1 LWA + \beta_2 LPOP + \beta_3 LMFI + \beta_4 LMME$.

[b] Standard error of estimated LWU.

[c] Projected visitor days (in thousands).

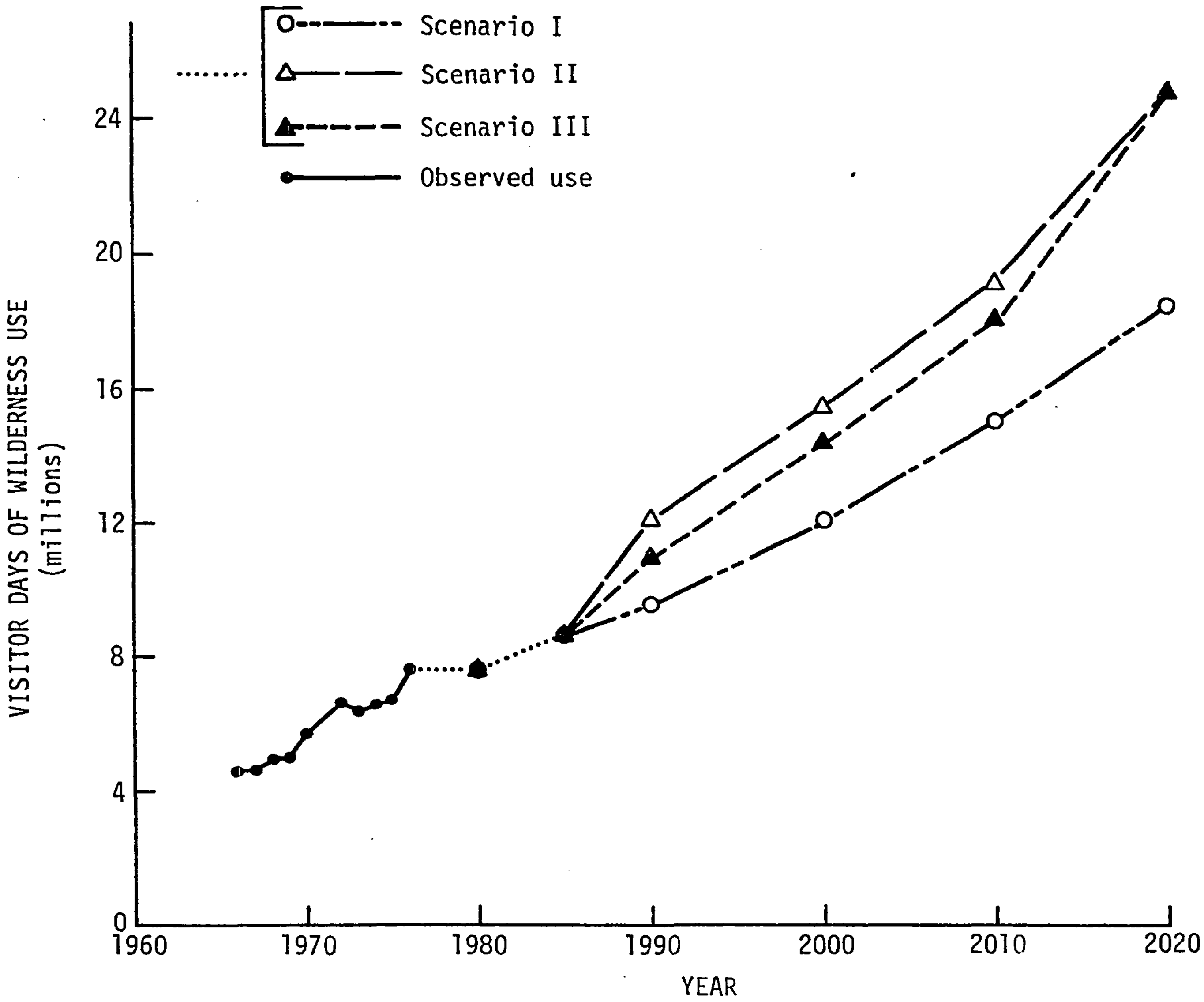
since all three scenarios assume constant wilderness acreage until 1985, they all result in the same estimated use for 1980 and 1985. Additionally, since scenarios II and III assume completion of RARE II suggested additions by 2020, both scenarios result in the same use projections for that year.

To indicate national trend for the projection years, projected regional components were added for each projection year. Totals for each year for the three scenarios were then plotted along with observed use for 1966 through 1975 (Figure 12).

The plot of the national trend and the regional components indicate a sizable difference in projected use depending on the scenario being used, with the greatest difference between the no increase scenario and inclusion of all acreage recommended in alternative D by 1990. A word of caution is in order, however, in regard to the use levels projected by scenario I.

Wilderness areas are not physically created by Congress. They have always been in existence and the absence of an "official" wilderness designation has not made the RARE II study areas less wild, although this may change once an alternative is decided upon. Since these nondesignated areas are just as much wilderness as designated areas, they also receive significant amounts of recreation use which is not presently recorded by the Forest Service. If these areas are designated as wilderness, this use will begin to be recorded and the wilderness use projections depicted by scenario II or III will be appropriate assuming alternative D is chosen. If none of the recommended areas are designated

Figure 12. National trend in projected wilderness use using the model $LWU = \beta_0 + \beta_1 LWA + \beta_2 LPOP + \beta_3 LMFI + \beta_4 LMME$ assuming three scenarios of wilderness area increase



Scenario I
Scenario II
Scenario III
Observed use
VISITOR DAYS OF WILDERNESS USE
(millions)
0
4
8
12
16
20
24
1960
1970
1980
1990
2000
2010
2020
YEAR

as wilderness, however, observed use may be higher than that projected by scenario I. As the areas studied in RARE II are allowed to develop for uses other than wilderness, those people who had previously found a "wilderness experience" in nonwilderness areas may be forced to seek wilderness type recreation in designated areas. Over time, this could result in an influx of "new" users to designated areas leading to observed use in excess of scenario I projected use.

CHAPTER V. DEVELOPMENT OF A LAGGED USE MODEL

General

While the model developed in the previous chapter does a reasonable job of explaining the variation in observed wilderness use, it was felt that incorporation of the trend in wilderness use might result in a model which more adequately explains use variation. To account for the trend in use, a model containing past wilderness use as an independent variable, in conjunction with other explanatory variables, was hypothesized. As stated in the previous chapter, however, inclusion of a lagged use variable introduces problems of multicollinearity and violates the assumptions on which time-series cross-section regression is based. Because of this, it is necessary to use ordinary least squares regression with some modifications to obtain a model which explains regional variation in use without encountering problems of multicollinearity between lagged regional use and the other regional variables in the model. To do this, the following approach was used.

A model of the form

$$Y_t^R = \mu + \sum_{i=1}^{m-1} \alpha_i D_i + \sum_{j=1}^{p} \beta_j X_j^R + \sum_{k=1}^{s} \gamma_k X_k^N + \lambda Y_{t-1}^R$$

can be used where

Y_t^R = wilderness use in region R at time t

D_i = a set of dummy variables

X_j^R = a set of p regional variables

X_k^N = a set of s national variables, and

m = the number of regions subject to the constraint that

$$\sum_{i=1}^{m} \alpha_i = 0$$

This might be termed a "within regions" model since use of the dummy variables allows estimation of within region intercepts. Average effects of the regional variables are not accounted for in such a model, however.

By making use of the fact that residuals from an OLS regression have zero correlation with the independent variables in the regression, it is possible to formulate a model which allows regional intercept estimates, accounts for average effects of regional variables, and reduces the problem of multicollinearity.

To account for average effects of the regional variables, the following procedure can be used. For each regional variable, the average value over time for each region in the data base must be calculated. These average values can then be used as independent variables in a regression with dummy variables as dependent variables. Since the aim is to create a set of residual variables which are orthogonal to the original regional variables, more than one regression is required. For example, in the present situation, eight regions are being modeled so seven variables are required in total. Thus, if two regional variables are to be used in a model, five others must be constructed by using five dummy variables in turn as dependent variables, in five regressions of the form

$$D_{ij} = \alpha + \beta_1 \overline{X}^R_{1j} + \beta_2 \overline{X}^R_{2j} \qquad i = 1, 2, \ldots 5 \quad j = 1, 2, \ldots m$$

where $\overline{X}^R_{1j}$ and $\overline{X}^R_{2j}$ are average values over time for each of m regions.

Once regression coefficients have been estimated, residuals for each regression can be calculated by

$$DV_{ij} = D_{ij} - \hat{D}_{ij}$$

where DV_{ij} = region j residual for regression i, and $\hat{D}_{ij}$ = the regression estimate of D_{ij}.

In the present example, this procedure will result in five columns of residuals, each containing eight values. By the nature of OLS, these residuals are independent of the original regional variables. The resulting equation for this example would then be

$$Y^R_t = \mu + \sum_{i=1}^{5} \alpha_i \, DV^R_i + \sum_{j=1}^{2} \beta_j \, X^R_j + \sum_{k=1}^{s} \gamma_k \, X^N_k + \lambda Y^R_{t-1}$$

where DV^R_i is the ith column of residuals for region R. This model could be termed a "between regions" model.

The same approach can be used with more than two regional variables by reducing the number of residual variables so that the sum of residual and regional variables forms a complete set of seven variables.

Model Development

Regional acreage and population model

Using the approach outlined in the previous section, an attempt was made to develop a model which explained more of the variation in wilderness use than the model specified in Chapter IV. Variables used initially were $\log_{10}$ transformations of regional wilderness acreage, regional population, national population, and regional wilderness use for the preceeding year.

It was first necessary to compute residual values to be used in the model. Average values for $\log_{10}$ regional wilderness acreage and $\log_{10}$ regional population were calculated for each of the eight regions and used as independent variables in each of five regressions of the form

$$D_{ij} = \alpha + \beta_1 \overline{LWA}_j + \beta_2 \overline{LPOP}_j \qquad \begin{array}{l} i = 1, 2, \ldots 5 \\ j = 1, 2, \ldots 8 \end{array}$$

where

$\overline{LWA}_j$ = average log of regional wilderness acreage over time for region j

$\overline{LPOP}_j$ = average log of regional population over time for j

From these regressions, five columns of residuals were calculated. These residuals were then used with the variables previously mentioned, in the following regression

$$LWU_{jt} = \mu + \sum_{i=1}^{5} \alpha_i \, DV_{ij} + \beta_1 LWA_{jt} + \beta_2 LPOP_{jt} + \gamma_1 LNPOP_t + \lambda \, LWU_{t-1}$$

$$\text{region} = j = 1, 2, \ldots 8; \ \text{year} = t = 1, 2, \ldots 10$$

where

LWU_{jt} = $\log_{10}$ wilderness use

$LPOP_{jt}$ = $\log_{10}$ regional population

$LNPOP_t$ = $\log_{10}$ national population

DV_{ij} = residual values from OLS regression

To enable a test of the hypothesis of no difference in slope for the between regions model and the within regions model, a second regression was run substituting seven dummy variables for the five columns of residuals. Table 17 shows the results of the regression using residuals and Table 18 shows the results of the regression using dummy variables.

While the coefficients associated with LWA, LPOP, LNPOP, and LWU_{t-1} are all highly significant, the test of the hypothesis of equal slopes for the two models is also significant at the 90 percent level (F^2_{66} = 2.597). Thus, there is reason to believe that regional variation is not properly accounted for using these variables.

Incorporation of regional number of wilderness areas

It was hypothesized that number of wilderness areas within each region might be important when using this regression technique since additions to wilderness often take the form of new areas rather than additional acreage in an existing area. To test this hypothesis, a procedure similar to that discussed previously was used. Since there are now three regional variables, LWA, LPOP, and LNA, where LNA is $\log_{10}$ number of wilderness areas within each region, only four dummy variables were regressed on an intercept and average logs of the three regional variables. From these regressions, four sets of residuals were calculated as before for inclusion in the final regression:

Table 17. Results of regression using regional acreage, regional population, national population, and lagged use with residuals

Source	b value	Standard error	t for H_o:β=0	Prob.>$\|t\|$
Intercept	-25.3341	5.6026	-4.5218	0.0001
LWA	0.6977	0.0709	9.8371	0.0001
LPOP	0.3824	0.3824	9.9367	0.0001
LNPOP	2.7335	0.6656	4.1068	0.0001
LWU_{t-1}	0.2484	0.0736	3.3747	0.0012
DV_1	-0.3119	0.1025	-3.0437	0.0033
DV_2	-0.0266	0.0201	-1.3216	0.1906
DV_3	-0.3113	0.0909	-3.4268	0.0010
DV_4	-0.2052	0.1098	-1.8683	0.0659
DV_5	0.4613	0.1024	4.5033	0.0001

Table 18. Results of regression using regional acreage, regional population, national population, and lagged use with dummy variables

Source	b value	Standard error	t for H_o:β=0	Prob.>|t|
Intercept	-18.5651	8.6787	-2.1392	0.0360
LWA	0.8215	0.0883	9.3029	0.0001
LPOP	0.0867	0.6944	0.1249	0.9010
LNPOP	1.9508	1.5280	1.2767	0.2060
LWU_{t-1}	0.4337	0.1221	3.5516	0.0007
D_1	-0.3537	0.5045	-0.7010	0.4857
D_2	-0.1096	0.0790	-1.3878	0.1697
D_3	-0.2306	0.3511	-0.6570	0.5134
D_4	-0.1704	0.4602	-0.3703	0.7123
D_5	0.1523	0.2790	0.5457	0.5871
D_6	-0.0815	0.1495	-0.5450	0.5875
D_7	0.6753	0.5497	1.2283	0.2236

$$LWU_{jt} = \mu + \sum_{i=1}^{4} \alpha_i \; DV_{ij} + \beta_1 LWA_{jt} + \beta_2 LNA_{jt} + \beta_3 LPOP_{jt}$$

$$+ \gamma_1 LNPOP_t + \lambda LWU_{t-1}$$

where LNA_{jt} = $\log_{10}$ number of wilderness areas in region j during year t, and all other variables are as before.

A second regression substituting dummy variables for residuals was also run. Results of the two regressions are shown in Tables 19 and 20. A comparison of Table 19 with Table 17 reveals that the standard error of coefficients associated with LWA, LPOP, LNPOP, and LWU_{t-1} have been improved by addition of regional number of wilderness areas in the model. Also, Table 19 shows that all of the log variables including LNA have coefficients significantly different from zero at the 99 percent level. As a final check of the models adequacy, an F test of the hypothesis of equal slopes for the two models was calculated and found to be not significant at the 90 percent level (calculated $F^3_{67} = 1.204$), indicating that regional variation in wilderness use is appropriately modeled.

Predicted vs. actual use using the lagged use model

To evaluate the lagged use model, and to allow for comparisons with other models developed in this study, adjusted R^2 values were calculated for each region and for the national total as described in Chapter IV. Table 21 shows R^2 and $\bar{R}^2$ for the lagged use model.

$\bar{R}^2$ for national total increased from 0.81 to 0.91. Thus, the lagged use model fits the data better than does the previous model. The

Table 19. Results of regression using regional acreage, regional number of areas, regional population, national population, lagged use, and residuals

Source	b value	Standard error	t for $H_o:\beta=0$	Prob.>|t|
Intercept	-20.6900	5.4157	-3.8203	0.0003
LWA	0.5722	0.0610	9.3851	0.0001
LNA	0.1769	0.0292	6.0538	0.0001
LPOP	0.3701	0.0367	10.0925	0.0001
LNPOP	2.2075	0.6456	3.4193	0.0011
LWU_{t-1}	0.3217	0.0608	4.8686	0.0001
DV_1	0.0326	0.0338	0.9664	0.3372
DV_2	-0.1024	0.0308	-3.3202	0.0014
DV_3	-0.1077	0.0682	-1.5786	0.1189
DV_4	0.2536	0.0359	7.0913	0.0001

Table 20. Results of regression using regional acreage, regional number of areas, regional population, national population, lagged use, and dummy variables

Source	b value	Standard error	t for $H_o:\beta=0$	Prob.>|t|
Intercept	-17.1218	9.2643	-1.8481	0.0690
LWA	0.7726	0.1377	5.6114	0.0001
LNA	0.0557	0.1198	0.4651	0.6433
LPOP	0.1729	0.7226	0.2393	0.8116
LNPOP	1.7276	1.6100	1.0730	0.2871
LWU_{t-1}	0.4439	0.1247	3.5581	0.0007
D_1	-0.2728	0.5364	-0.5086	0.6127
D_2	-0.1056	0.0799	-1.3224	0.1905
D_3	-0.1939	0.3618	-0.5358	0.5939
D_4	-0.0886	0.4952	-0.1790	0.8585
D_5	0.1058	0.2979	0.3554	0.7234
D_6	-0.0660	0.1540	-0.4287	0.6695
D_7	0.5685	0.5987	0.9496	0.3457

Table 21. R^2 and $\bar{R}^2$ for the lagged use model by region and national total

Region	R^2	$\bar{R}^2$
1	0.50	0.47
2	0.81	0.79
3	0.60	0.57
4	0.04	0.00
5	0.81	0.79
6	0.36	0.32
8	0.95	0.95
9	0.42	0.38
National	0.92	0.91

reason for the large fluctuations in use in region 4 which results in an $\bar{R}^2$ of 0 is not apparent, though it is conceivable that improvements in the use estimation and reporting procedures might eliminate this pattern of fluctuation in the future. Figures 12 through 20 show the relation of predicted use to observed use for each of the eight regions. Figure 21 compares the total observed use for the nation with total predicted use.

Projections

The lagged use model was used to project wilderness use based on the three scenarios explained in Chapter IV. Values for regional population and regional wilderness acreage are the same as those used in Chapter IV. In addition to these, the values for national population and regional

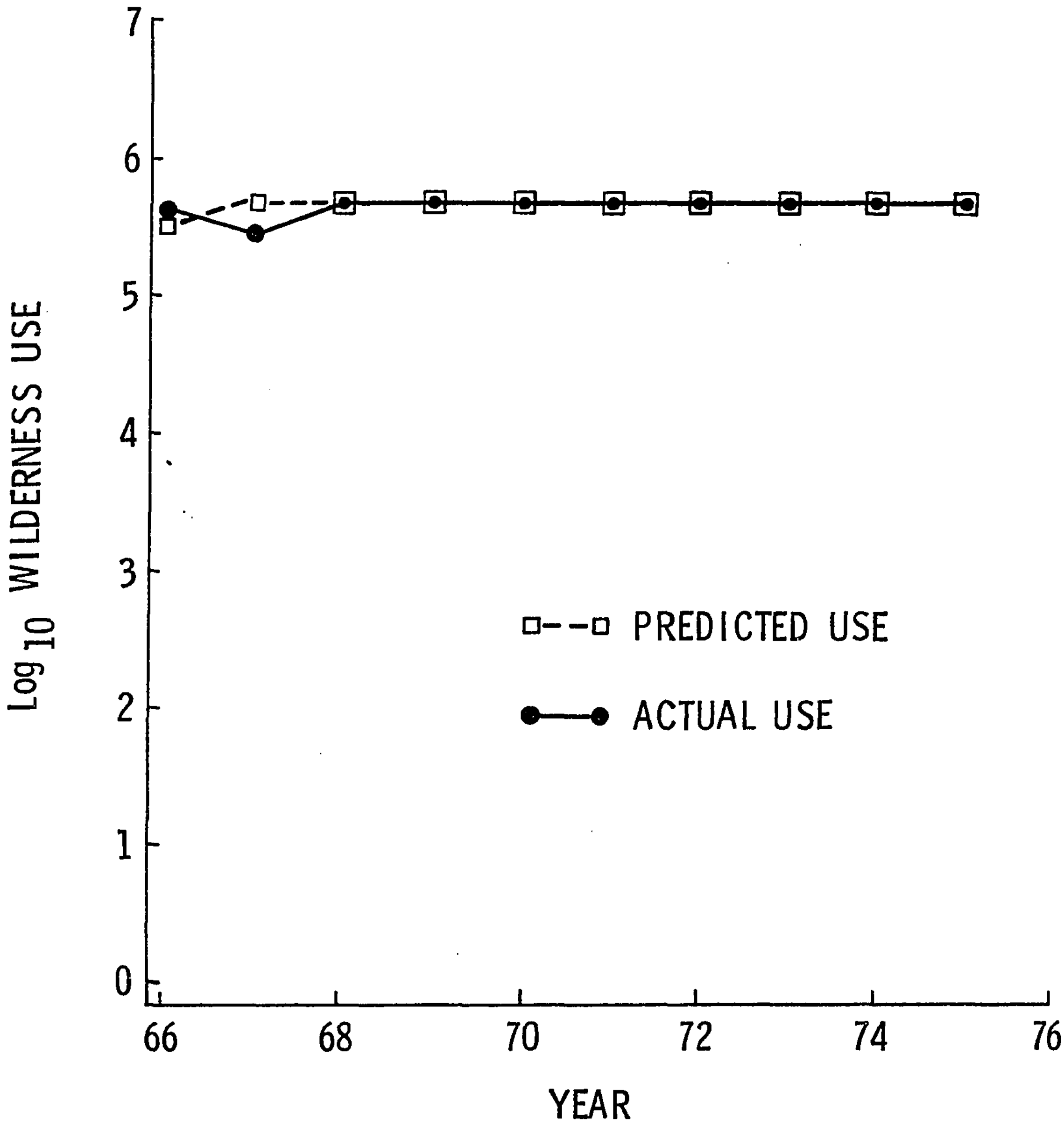


Figure 13. Region 1 predicted and actual use for 1966 through 1975 using the model $LWU_t = \mu + \Sigma\, \alpha_i\, DV_i + \beta_1 LWA + \beta_2 LNA + \beta_3 LPOP + \gamma_1 LNPOP + \lambda LWU_{t-1}$

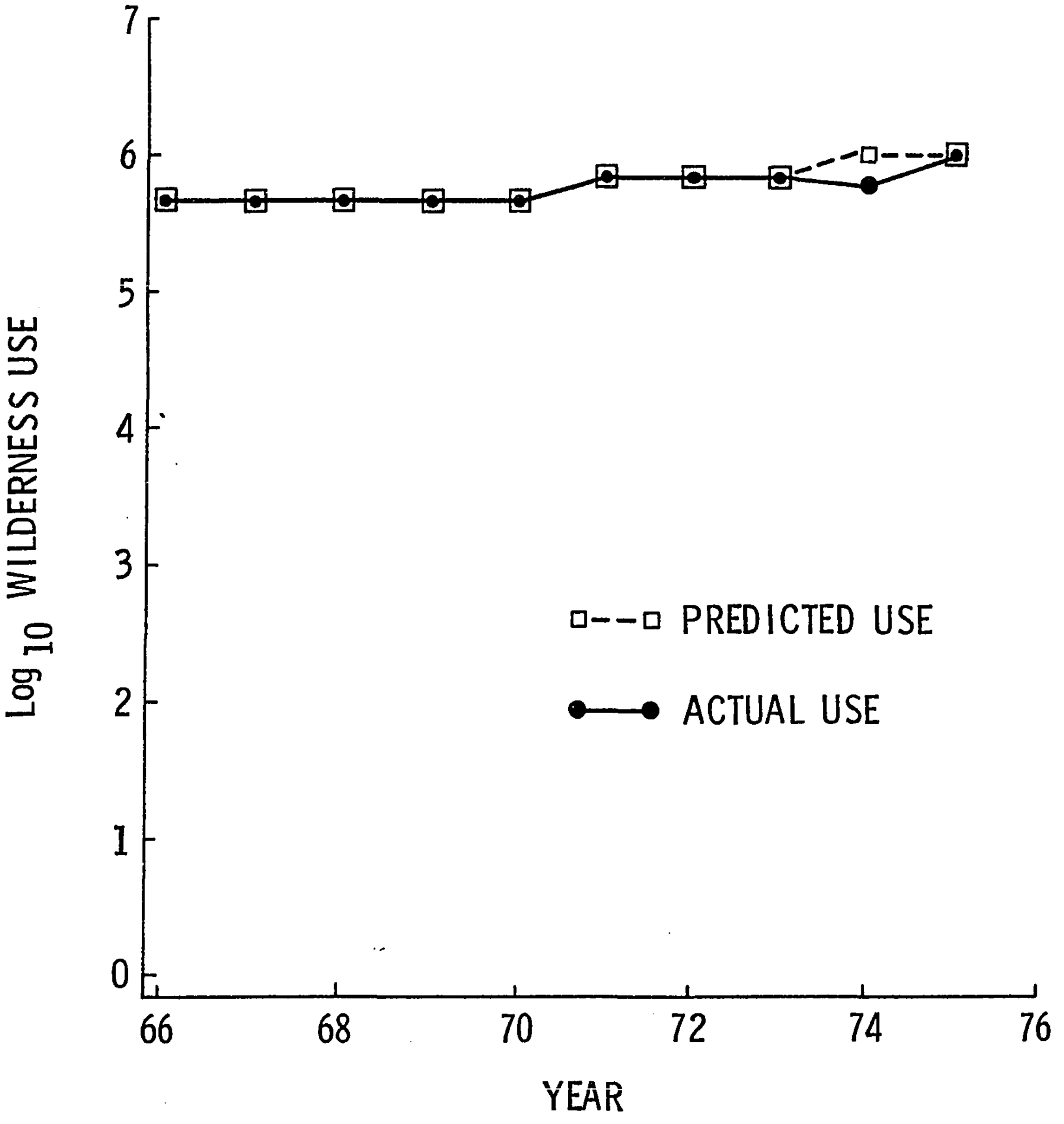


Figure 14. Region 2 predicted and actual use for 1966 through 1975 using the model $LWU_t = \mu + \Sigma\ \alpha_i\ DV_i + \beta_1 LWA + \beta_2 LNA + \beta_3 LPOP + \gamma_1 LNPOP + \lambda LWU_{t-1}$

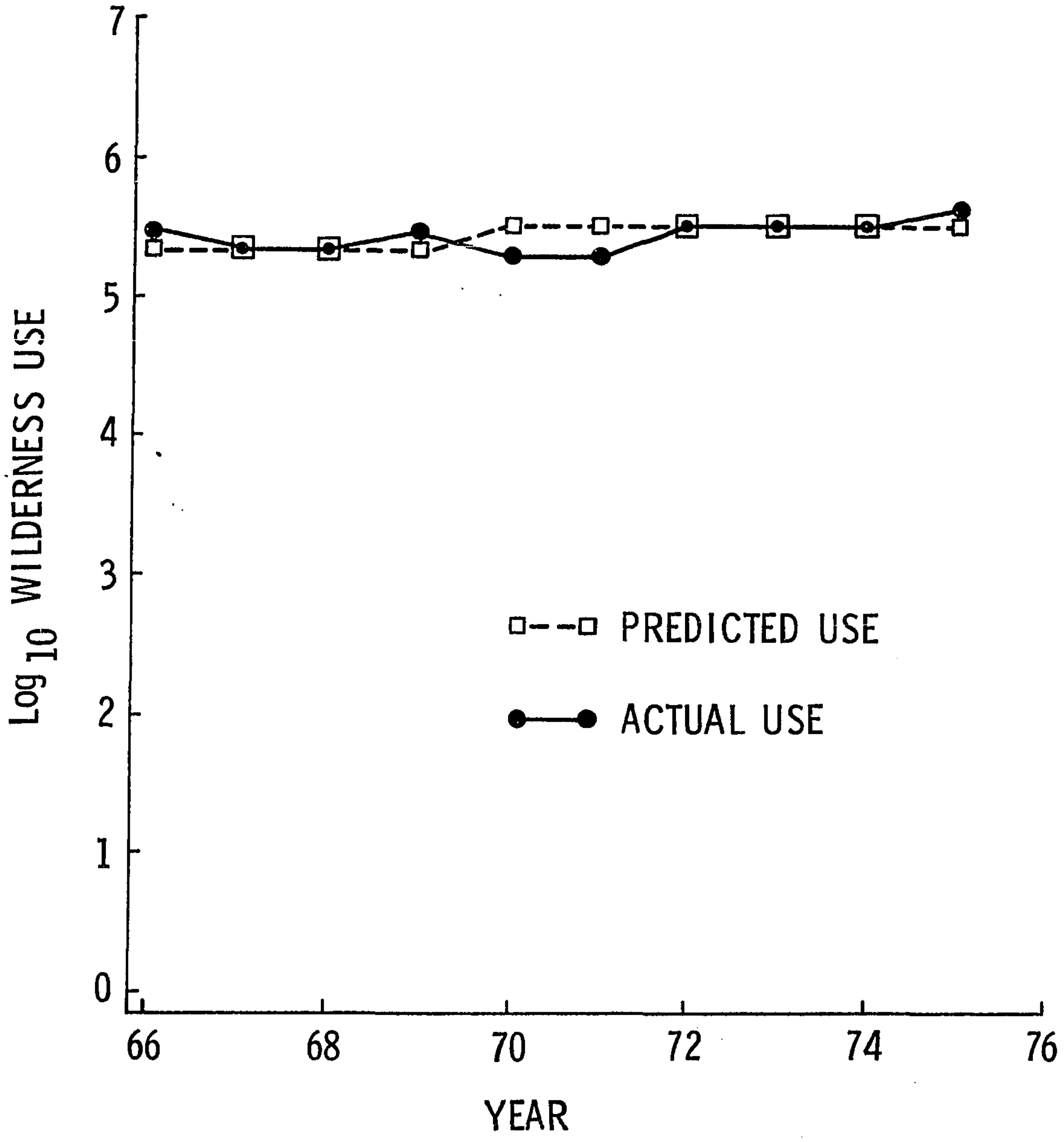


Figure 15. Region 3 predicted and actual use for 1966 through 1975 using the model $LWU_t = \mu + \Sigma\ \alpha_i\ DV_i + \beta_1 LWA + \beta_2 LNA + \beta_3 LPOP + \gamma_1 LNPOP + \lambda LWU_{t-1}$

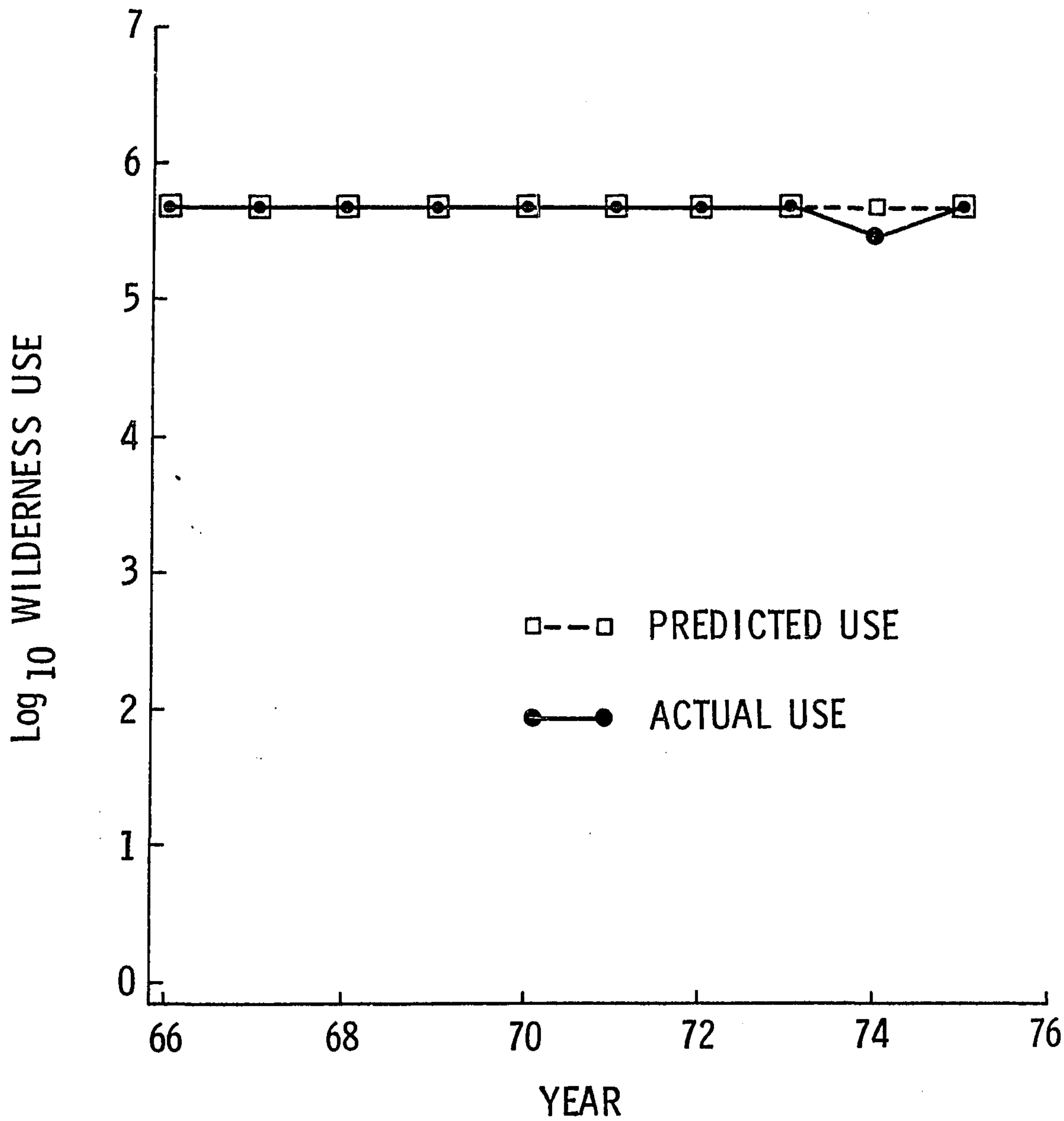


Figure 16. Region 4 predicted and actual use for 1966 through 1975 using the model $LWU_t = \mu + \Sigma\ \alpha_i\ DV_i + \beta_1 LWA + \beta_2 LNA + \beta_3 LPOP + \gamma_1 LNPOP + \lambda LWU_{t-1}$

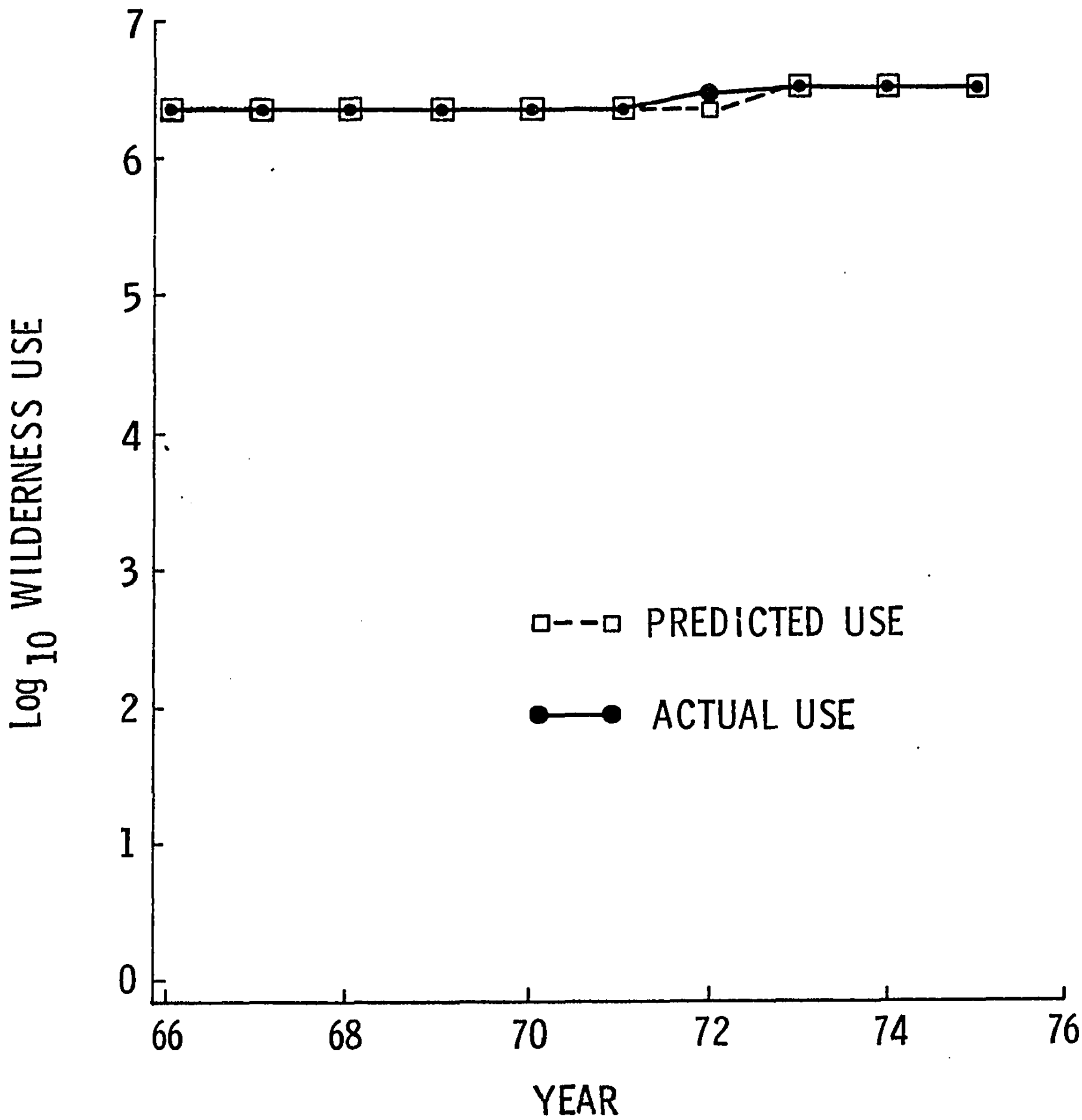


Figure 17. Region 5 predicted and actual use for 1966 through 1975 using the model $LWU_t = \mu + \Sigma \alpha_i DV_i + \beta_1 LWA + \beta_2 LNA + \beta_3 LPOP + \gamma_1 LNPOP + \lambda LWU_{t-1}$

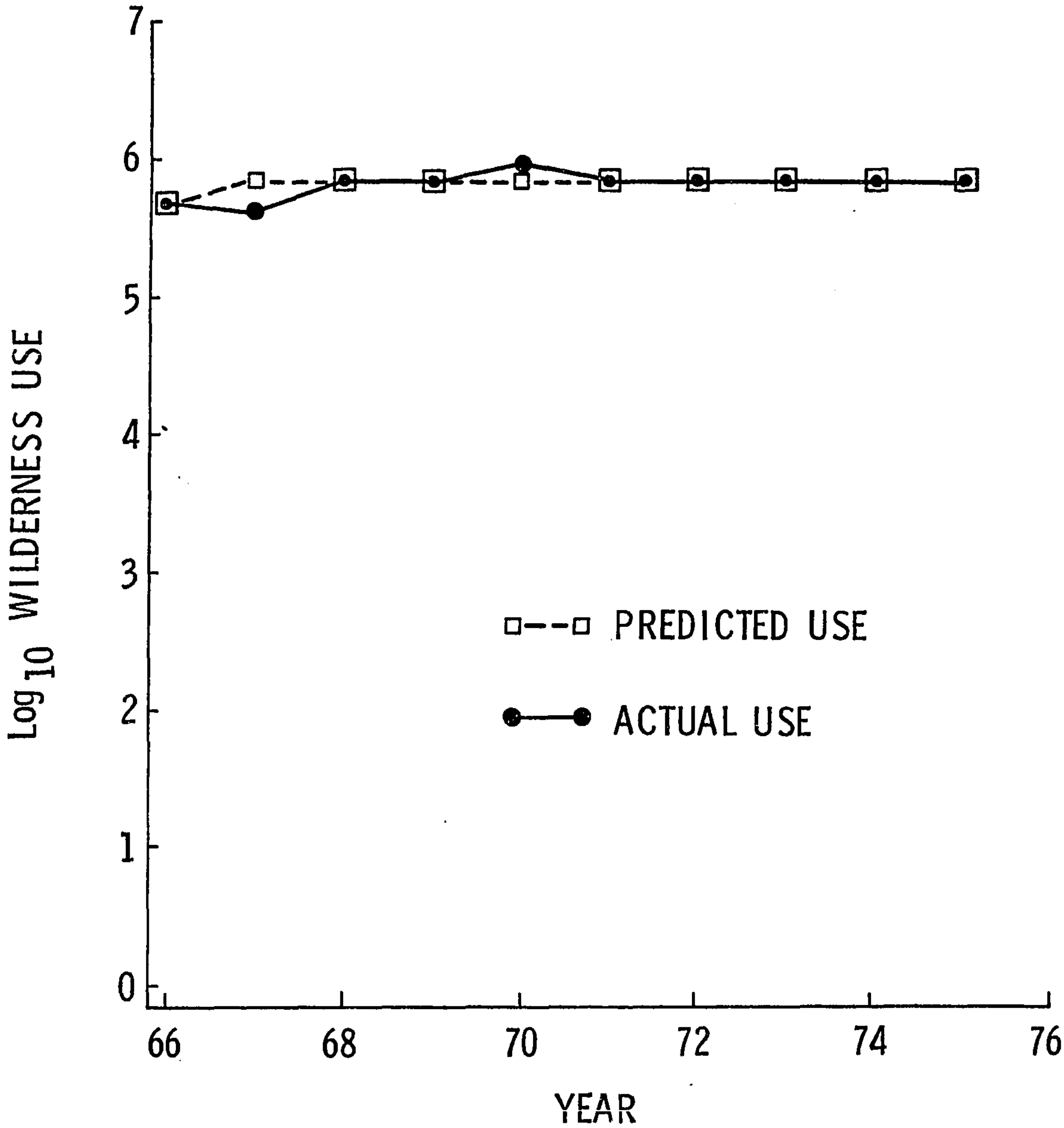


Figure 18. Region 6 predicted and actual use for 1966 through 1975 using the model $LWU_t = \mu + \Sigma\ \alpha_i\ DV_i + \beta_1 LWA + \beta_2 LNA + \beta_3 LPOP + \gamma_1 LNPOP + \lambda LWU_{t-1}$

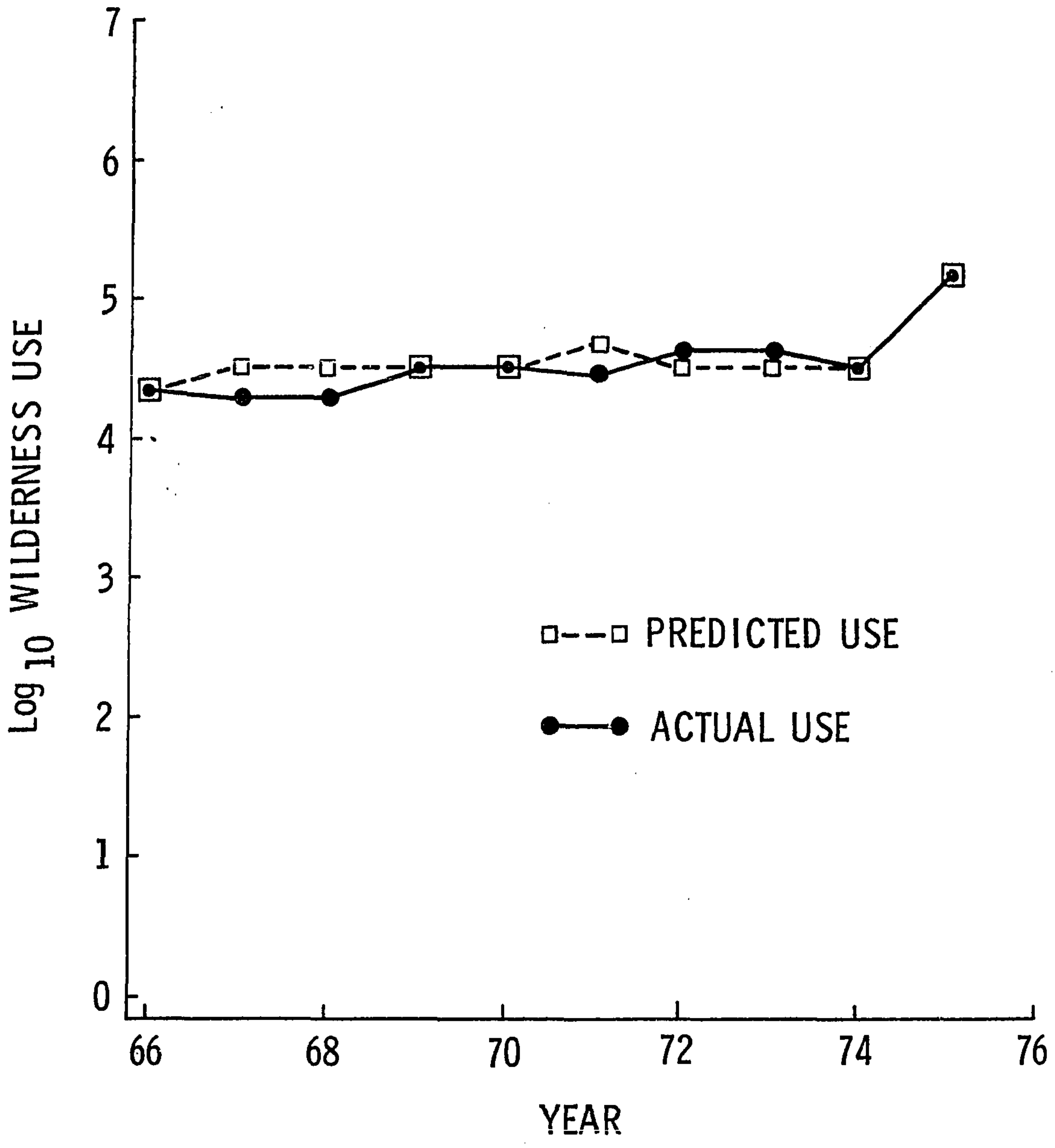


Figure 19. Region 8 predicted and actual use for 1966 through 1975 using the model $LWU_t = \mu + \Sigma\, \alpha_i\, DV_i + \beta_1 LWA + \beta_2 LNA + \beta_3 LPOP + \gamma_1 LNPOP + \lambda LWU_{t-1}$

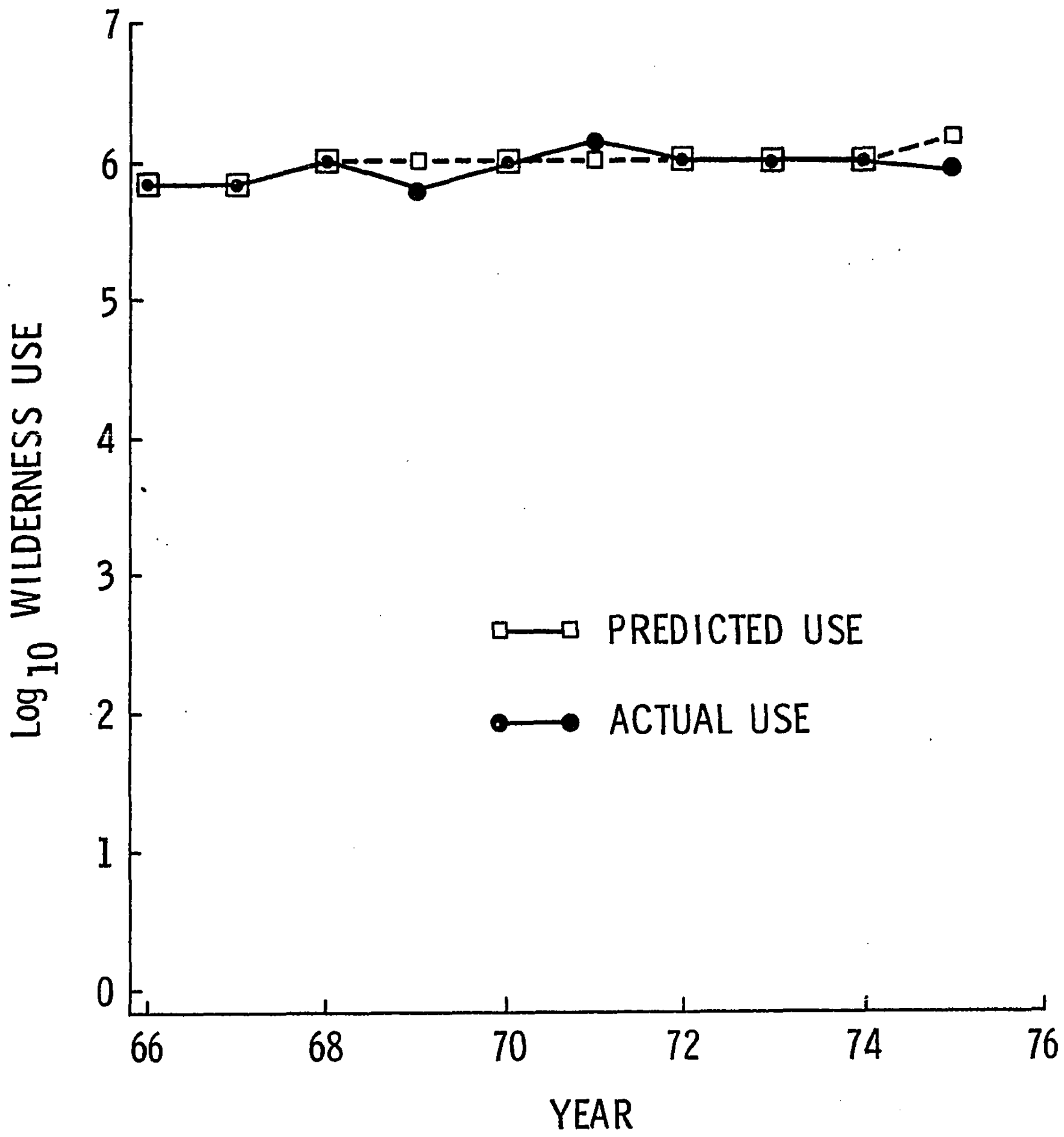


Figure 20. Region 9 predicted and actual use for 1966 through 1975 using the model $LWU_t = \mu + \Sigma\ \alpha_i\ DV_i + \beta_1 LWA + \beta_2 LNA + \beta_3 LPOP + \gamma_1 LNPOP + \lambda LWU_{t-1}$

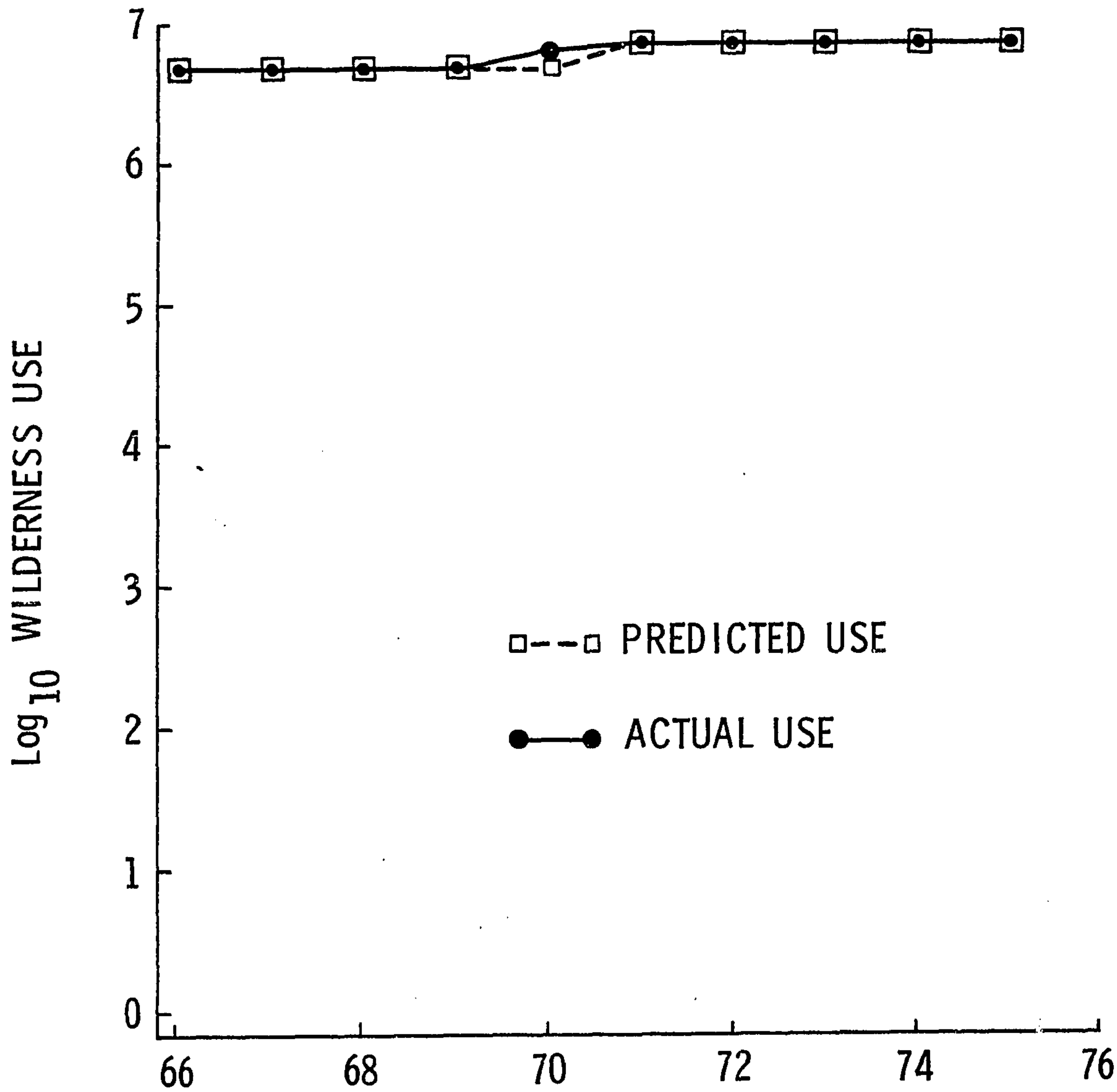


Figure 21. National total predicted and actual use for 1966 through 1975 using the model $LWU_t = \mu + \Sigma\, \alpha_i\, DV_{ij} + \beta_1 LWA + \beta_2 LNA + \beta_3 LPOP + \gamma_1 LNPOP + \lambda LWU_{t-1}$

number of wilderness areas shown in Table 22 were used in making projections. National population figures are those projected by the Obers study while number of areas are those suggested by alternative D of the RARE II study.

Because of the inclusion of lagged use in the model, a slightly modified technique must be used for projections. An iterative projection technique was used whereby use was projected for each year from 1976 through 2020. Projected use was then substituted into the model as the lagged use for the following year. Thus, use for 1976 was projected using observed use from 1975. This projected use was then used as the lagged value for projection of 1977 use, and so on until use for the year 2020 had been projected.

To reduce the amount of calculations necessary, it is possible to combine

$$\Sigma_{i=1}^{4} \alpha_i \, DV_{ij}$$

with μ to form a unique estimate of the intercept for each region since the DV_{ij} are constant within each region. Table 23 shows the intercept for each region calculated in this manner.

Once projections for all years were made, use estimates for the years of interest were extracted. Tables 24 through 31 show regional projections obtained. Figure 22 shows the projected national trend using the lagged use model. The trend projected with this model is considerably higher than that of the previous model. The trend in projections does, however, match the 1966 to 1975 trend more closely as is expected since

Table 22. Values for national population and regional number of wilderness areas used in projections

	1980	1985	1990	2000	2010	2020
National population	234,208[a]	251,984	269,759	306,782	350,111	399,013
Region 1	11[b]	------	------	No increase	------	------
	11[c]	11	72	------	No increase	------
	11[d]	11	42	57	57	72
Region 2	17	------	------	No increase	------	------
	17	17	63	------	No increase	------
	17	17	41	52	52	63
Region 3	16	------	------	No increase	------	------
	16	16	55	------	No increase	------
	16	16	35	45	45	55
Region 4	5	------	------	No increase	------	------
	5	5	63	------	No increase	------
	5	5	35	44	44	63
Region 5	21	------	------	No increase	------	------
	21	21	76	------	No increase	------
	21	21	48	62	62	76

[a]Population in thousands.

[b]Scenario I.

[c]Scenario II.

[d]Scenario III.

Table 22 (continued)

	1980	1985	1990	2000	2010	2020
	14----------	----------	----------	-No increase-	----------	----------
Region 6	14	14	74----------	----------	-No increase-	----------
	14	14	44	59	59	74
	11----------	----------	----------	-No increase-	----------	----------
Region 8	11	11	68----------	----------	-No increase-	----------
	11	11	40	54	54	68
	8----------	----------	----------	-No increase-	----------	----------
Region 9	8	8	37----------	----------	-No increase-	----------
	8	8	23	30	30	37

Table 23. Regional models with residuals incorporated in the intercept term

Region	Adjusted intercept	Portion of model common to all regions
1	-20.7344	
2	-20.7520	
3	-20.8176	
4	-20.5681	$.5722(LWA_t) + .1769(LNA) + .3701(LPOP) + 2.2075(LNPOP) + .3217(LWU_{t-1})$
5	-20.5658	
6	-20.6721	
8	-20.6801	
9	-20.7462	

Table 24. Wilderness use projections for region 1 using three scenarios of wilderness area increase

Year	Scenario I	Scenario II	Scenario III
1980	5.867[a] (0.079)[b] 736[c]	5.867 (0.079) 736	5.867 (0.079) 736
1985	5.976 (0.090) 946	5.976 (0.090) 946	5.976 (0.090) 946
1990	6.077 (0.103) 1,194	6.404 (0.104) 2,535	6.287 (0.103) 1,936
2000	6.272 (0.130) 1,871	6.599 (0.132) 3,972	6.546 (0.131) 3,516
2010	6.475 (0.162) 2,985	6.801 (0.163) 6,324	6.748 (0.163) 5,598
2020	6.678 (0.195) 4,764	7.002 (0.196) 10,046	7.002 (0.196) 10,046

[a] $LWU_t = \beta_0 + \beta_1 LWA_t + \beta_2 LNA_t + \beta_3 LPOP_t + \gamma_1 LNPOP_t + \lambda LWU_{t-1}$.

[b] Standard error of projected LWU.

[c] Projected visitor days (in thousands).

Table 25. Wilderness use projections for region 2 using three scenarios of wilderness area increase

Year	Scenario I	Scenario II	Scenario III
1980	6.083[a] (0.078)[b] 1,211[c]	6.083 (0.078) 1,211	6.083 (0.078) 1,211
1985	6.201 (0.089) 1,589	6.201 (0.089) 1,589	6.201 (0.089) 1,589
1990	6.311 (0.102) 2,046	6.515 (0.104) 3,273	6.438 (0.103) 2,742
2000	6.518 (0.130) 3,296	6.722 (0.131) 5,272	6,687 (0.131) 4,864
2010	6.732 (0.161) 5,395	6.935 (0.162) 8,610	6.899 (0.162) 7,925
2020	6.944 (0.194) 8,790	7.146 (0.195) 13,996	7.146 (0.195) 13,996

[a] $LWU_t = \beta_0 + \beta_1 LWA_t + \beta_2 LNA_t + \beta_3 LPOP_t + \gamma_1 LNPOP_t + \lambda LWU_{t-1}$.

[b] Standard error of projected LWU.

[c] Projected visitor days (in thousands).

Table 26. Wilderness use projections for region 3 using three scenarios of wilderness area increase

Year	Scenario I	Scenario II	Scenario III
1980	5.683[a] (0.078)[b] 482[c]	5.683 (0.078) 482	5.683 (0.078) 482
1985	5.781 (0.089) 604	5.781 (0.089) 604	5.781 (0.089) 604
1990	5.865 (0.102) 733	6.120 (0.103) 1,318	6.015 (0.103) 1,035
2000	6.101 (0.130) 1,262	6.356 (0.131) 2,270	6.307 (0.131) 2,028
2010	6.316 (0.161) 2,070	6.570 (0.162) 3,715	6.521 (0.162) 3,319
2020	6.526 (0.194) 3,357	6.779 (0.195) 6,012	6.779 (0.195) 6,012

[a] $LWU_t = \beta_0 + \beta_1 LWA_t + \beta_2 LNA_t + \beta_3 LPOP_t + \gamma_1 LNPOP_t + \lambda\ LWU_{t-1}$.

[b] Standard error of projected LWU.

[c] Projected visitor days (in thousands).

Table 27. Wilderness use projections for region 4 using three scenarios of wilderness area increase

Year	Scenario I	Scenario II	Scenario III
1980	5.878[a] (0.079)[b] 755[c]	5.878 (0.079) 755	5.878 (0.079) 755
1985	6.005 (0.090) 1,012	6.005 (0.090) 1,012	6.005 (0.090) 1,012
1990	6.122 (0.103) 1,324	6.657 (0.103) 4,539	6.486 (0.102) 3,062
2000	6.340 (0.131) 2,188	6.877 (0.130) 7,536	6.787 (0.130) 6,124
2010	6.564 (0.162) 3,664	7.100 (0.163) 12,589	7.010 (0.162) 10,233
2020	6.786 (0.195) 6,109	7.321 (0.194) 20,941	7.321 (0.194) 20,941

[a] $LWU_t = \beta_0 + \beta_1 LWA_t + \beta_2 LNA_t + \beta_3 LPOP_t + \gamma_1 LNPOP_t \quad \lambda\, LWU_{t-1}$.

[b] Standard error of projected LWU.

[c] Projected visitor days (in thousands).

Table 28. Wilderness use projections for region 5 using three scenarios of wilderness area increase

Year	Scenario I	Scenario II	Scenario III
1980	6.603[a] (0.078)[b] 4,009[c]	6.602 (0.078) 4,009	6.602 (0.078) 4,009
1985	6.733 (0.089) 5,408	6.733 (0.089) 5,408	6.733 (0.089) 5,408
1990	6.851 (0.101) 7,096	7.064 (0.104) 11,588	6.979 (0.103) 9,528
2000	7.070 (0.129) 11,749	7.283 (0.131) 19,187	7.244 (0.131) 16,749
2010	7.293 (0.161) 19,634	7.505 (0.162) 31,989	7.466 (0.162) 29,242
2020	7.514 (0.193) 32,659	7.725 (0.195) 53,088	7.725 (0.195) 53,088

[a] $LWU_t = \beta_0 + \beta_1 LWA_t + \beta_2 LNA_t + \beta_3 LPOP_t + \gamma_1 LNPOP_t + \lambda LWU_{t-1}$.

[b] Standard error of projected LWU.

[c] Projected visitor days (in thousands).

Table 29. Wilderness use projections for region 6 using three scenarios of wilderness area increase

Year	Scenario I	Scenario II	Scenario III
1980	6.059[a] (0.078)[b] 1,146[c]	6.059 (0.078) 1,146	6.059 (0.078) 1,146
1985	6.182 (0.089) 1,521	6.182 (0.089) 1,521	6.182 (0.089) 1,521
1990	6.295 (0.102) 1,972	6.596 (0.104) 3,945	6.482 (0.103) 3,034
2000	6.506 (0.130) 3,206	6.803 (0.131) 6,353	6.753 (0.131) 5,662
2010	6.722 (0.161) 5,272	7.018 (0.162) 10,423	6.967 (0.162) 9,268
2020	6.935 (0.194) 8,610	7.230 (0.195) 16,982	7.230 (0.195) 16,982

[a] $LWU_t = \beta_0 + \beta_1 LWA_t + \beta_2 LNA_t + \beta_3 LPOP_t + \gamma_1 LNPOP_t + \lambda LWU_{t-1}$.

[b] Standard error of projected LWU.

[c] Projected visitor days (in thousands).

Table 30. Wilderness use projections for region 8 using three scenarios of wilderness area increase

Year	Scenario I	Scenario II	Scenario III
1980	5.569[a] (0.078)[b] 371[c]	5.569 (0.078) 371	5.569 (0.078) 371
1985	5.694 (0.089) 494	5.694 (0.089) 494	5.694 (0.089) 494
1990	5.807 (0.102) 641	6.517 (0.105) 3,289	6.285 (0.104) 1,928
2000	6.047 (0.130) 1,114	6.732 (0.132) 5,395	6.630 (0.132) 4,266
2010	6.265 (0.161) 1,841	6.949 (0.163) 8,892	6.847 (0.163) 7,031
2020	6.482 (0.194) 3,034	7.165 (0.195) 14,622	7.165 (0.195) 14,622

[a] $LWU_t = \beta_0 + \beta_1 LWA_t + \beta_2 LNA_t + \beta_3 LPOP_t + \gamma_1 LNPOP_t + \lambda LWU_{t-1}$.

[b] Standard error of projected LWU.

[c] Projected visitor days (in thousands).

Table 31. Wilderness use projections for region 9 using three scenarios of wilderness area increase

Year	Scenario I	Scenario II	Scenario III
1980	6.387[a] (0.078)[b] 2,438[c]	6.387 (0.078) 2,438	6.387 (0.078) 2,438
1985	6.512 (0.089) 3,251	6.512 (0.089) 3,251	6.512 (0.089) 3,251
1990	6.625 (0.101) 4,217	6.867 (0.104) 7,362	6.780 (0.103) 6,026
2000	6.835 (0.129) 6,839	7.077 (0.131) 11,940	7.036 (0.131) 10,864
2010	7.049 (0.161) 11,194	7.291 (0.162) 19,543	7.250 (0.162) 17,783
2020	7.339 (0.194) 21,827	7.579 (0.195) 37,931	7.579 (0.195) 37,931

[a] $LWU_t = \beta_0 + \beta_1 LWA_t + \beta_2 LNA_t + \beta_3 LPOP_t + \gamma_1 LNPOP_t + \lambda LWU_{t-1}$.

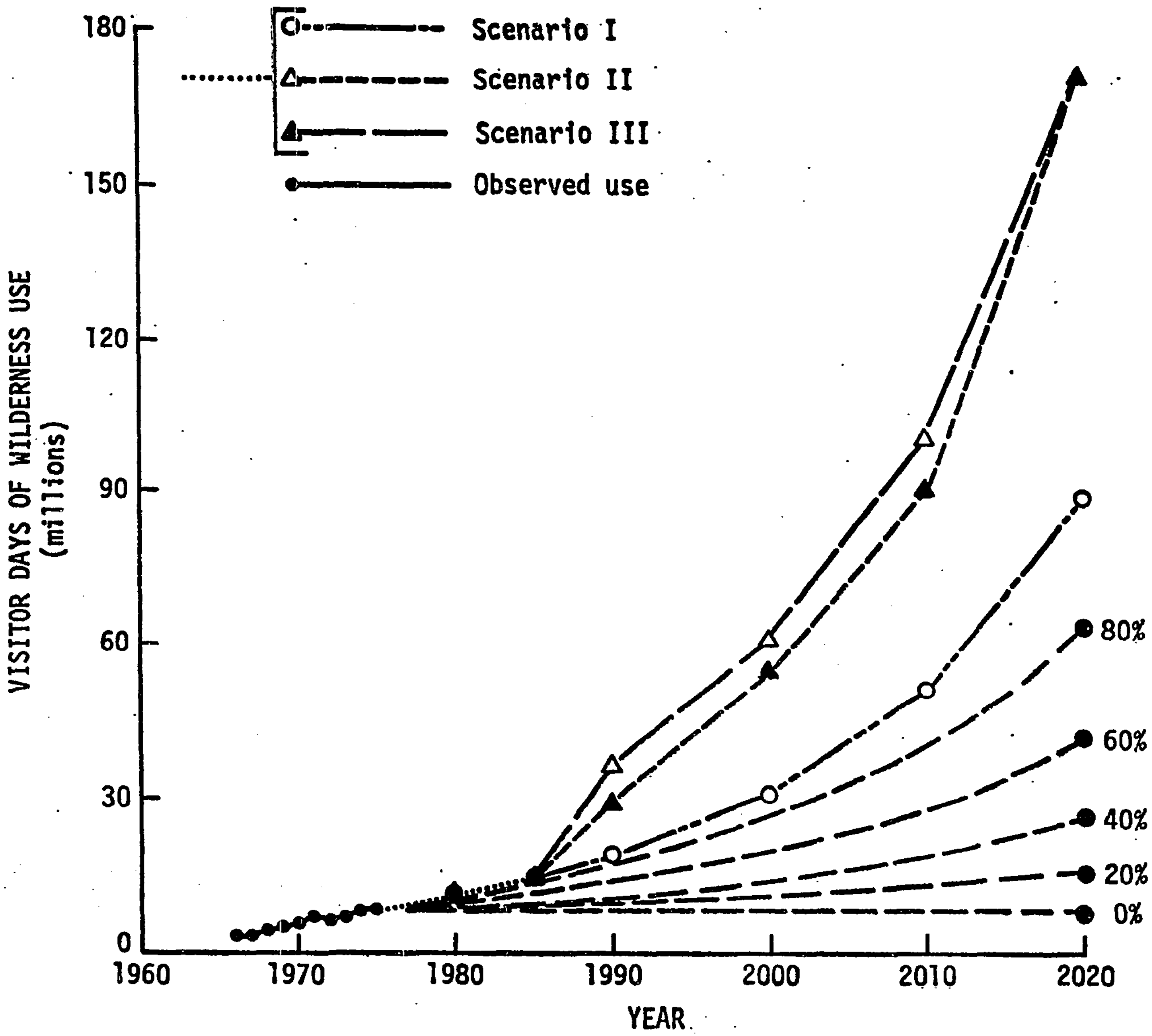
[b] Standard error of projected LWU.

[c] Projected visitor days (in thousands).

Figure 22. National trend in projected wilderness use using the model

$$LWU_t = \beta_0 + \beta_1 LWA + \beta_2 LNA + \beta_3 LPOP + \gamma_1 LNPOP + \lambda LWU_{t-1}$$

assuming three scenarios of wilderness area increase



Scenario I
Scenario II
Scenario III
Observed use
VISITOR DAYS OF WILDERNESS USE (millions)
180
150
120
90
60
30
0
1960
1970
1980
1990
2000
2010
2020
YEAR
80%
60%
40%
20%
0%

the regression fits the data more closely.

The same care must be exercised in interpreting projections assuming scenario I, since no acreage increase may lead to use in excess of that projected as discussed in Chapter IV.

Effect of population assumptions on use projections

In addition to the three scenarios used in making projections with the lagged use model, the effect of various population increases was evaluated. In 1975, the national population was approximately 217 million. Obers projections suggest that by 2020, that figure will have reached 399 million. Wilderness use projections were made for the year 2020 under assumptions of 0, 20, 40, 60, and 80 percent of the population increase estimated by Obers. Wilderness acreage and number of areas were held constant at the 1975 level. Results of this analysis are shown in Table 32. Figure 22 shows these projections in relation to the three primary scenarios used. It should be noted that where 0 percent of the projected population increase is used, all variables in the model except previous years use are held constant. Thus, the increase in projected wilderness use attributable to the lagged variable is less than one million visitor days. While the lagged variable does help account for changes in use patterns not otherwise detectable, it does not markedly inflate use estimates.

Coefficient modification

The iterative process used in projections based on the lagged model is somewhat cumbersome, though not unduly so with the aid of computers.

Table 32. Wilderness use projections for 2020 assuming no wilderness increase and selected percentage increases in population

Region	1975 observed use	Use projections for 2020					
		0%[a]	20%	40%	60%	80%	Scenario I[b]
1	479[c]	606	1,028	1,629	2,449	3,532	4,764
2	839	969	1,707	2,794	4,319	6,383	8,790
3	393	372	655	1,071	1,653	2,441	3,357
4	500	604	1,101	1,849	2,916	4,380	6,109
5	3,640	3,073	5,691	9,661	15,364	23,222	32,659
6	569	897	1,607	2,665	4,163	6,206	8,610
8	177	298	534	886	1,385	2,065	3,034
9	1,161	1,863	3,590	6,253	10,116	15,510	21,827
Total	7,758	8,682	15,913	26,808	42,365	63,739	89,150

[a]Percent of population increase projected by the Obers study from 1975 to 2020.

[b]Scenario I is equivalent to 100 percent of the Obers projected population increase.

[c]Estimated visitor days of use in thousands.

It is possible, however, to modify the coefficients of the regression so that the lagged variable is accounted for but not actually included in the projection model, thus avoiding the necessity of an iterative process.

Simplistically, if use in time t is assumed to be a function of a set of variables and use in time t-1, the equation for use can be written

$$Y_t = \beta_0 + \sum_{i=1}^{n} \beta_i X_i + \lambda Y_{t-1}$$

This being the case, Y_{t-1} can be found by

$$Y_{t-1} = \beta_0 + \sum_{i=1}^{n} \beta_i X_i + \lambda Y_{t-2}$$

The iterative projection process can then be written as one equation such that

$$Y_t = \beta_0 + \sum_{i=1}^{n} \beta_i X_i + \lambda \Big[\beta_0 + \sum_{i=1}^{n} \beta_i X_i + \lambda \{ \beta_0 + \sum_{i=1}^{n} \beta_i X_i + \lambda (\cdots \cdots + \lambda Y_{t-k}))) \cdots \} \Big]$$

In this manner, present use can be used as the lagged variable to project use in period t + k. Rather than use this approach, however, Dhrymes (1971) has shown that the coefficients in the equation can be modified to account for lagged use while not requiring it for projections. It is apparent from the iterative model above that the coefficient associated with Y_{t-k} is λ^k. Since $\lambda > 1$, λ^k approaches 0 as k increases. Dhrymes has shown that the limiting value for the other coefficients in the model as k increases is

$$\tilde{\beta}_i = \frac{\beta_i}{1-\lambda}$$

where $\tilde{\beta}_i$ is the modified coefficient.

Care must be exercised in using a modified equation of this nature since projections for years too close to the present will be overestimated significantly when compared to the iterative process. For that reason, a modified model was not used for making projections in this study. For projections beyond 15 to 20 years in the future, however, the modified equation yields estimates very close to those obtained through iteration and thus may be useful for comparing probable use levels related to various RARE II alternatives beyond the 2000. To this end, the modified regional models are provided in Table 33.

Table 33. Regional modified coefficient equations for use projections beyond the year 2000

Region	Intercept	Portion of equation common to all regions
1	-30.5682	
2	-30.5941	
3	-30.6908	
4	-30.3230	0.8436(LWA) + .2608(LNA) + .5456(LPOP) + 3.2545(LNPOP)
5	-30.3196	
6	-30.4763	
8	-30.4881	
9	-30.5856	

CHAPTER VI. DELETION OF THE LAGGED VARIABLE

General

As indicated in the previous chapter, projections of future wilderness use can be made with the lagged use model by adjusting coefficients of the model or by using an iterative process. Since the first method is biased for short range projections, and the second is time consuming, there may be a tendency to disregard the past use variable and make projections using the remaining coefficients on the assumption that projections so made will give acceptable approximations while avoiding adjustments or iterations necessary when lagged use is retained as a variable. While it should be readily apparent that such an approach will lead to at best, poor approximations of future use, a warning is in order, and a remedy is suggested.

If lagged use is deleted from the model, assumptions associated with time-series cross-section regression are no longer violated. Consequently, coefficients for a model similar to that developed in Chapter V excluding past use can be estimated using time-series cross-section regression. Such a model has the advantage of using only four variables, all of which are readily available, without the necessity of coefficient adjustments or iterative prediction. Therefore, the following model was fit using time-series cross-section regression:

$$LWU_{tj} = \beta_0 + \beta_1 LWA_{tj} + \beta_2 LNA_{tj} + \beta_3 LPOP_{tj} + \beta_4 LNPOP_t$$

where all variables are as defined before. Table 34 gives the results of the regression.

Table 34. Results of time-series cross-section regression using regional acreage, regional number of areas, regional population, and national population

Source	b values	Standard error	t for $H_0: \beta=0$	Prob.>|t|
Intercept	-32.5531	5.8837	-5.5327	0.0001
LWA	0.8342	0.1023	8.1545	0.0001
LNA	0.0324	0.1028	0.3155	0.7533
LPOP	0.4315	0.1132	3.8127	0.0003
LNPOP	3.6264	0.7371	4.9198	0.0001

With this model, projections of future wilderness use can be made using projected values for regional wilderness acreage, regional number of wilderness areas, regional population, and national population. Reliable projections for each of these variables should be available from Forest Service information and from census information.

Predicted vs. actual use for the shortened model

$\bar{R}^2$ values for the lagged and nonlagged models are not significantly different ($\bar{R}^2$ for the lagged model = 0.91; $\bar{R}^2$ for the nonlagged model = 0.906). For the sake of comparison, figures 23 through 30 show the regional components of predicted national wilderness use. Figure 31 shows the relation of actual use to predicted use for the years 1966 through 1975.

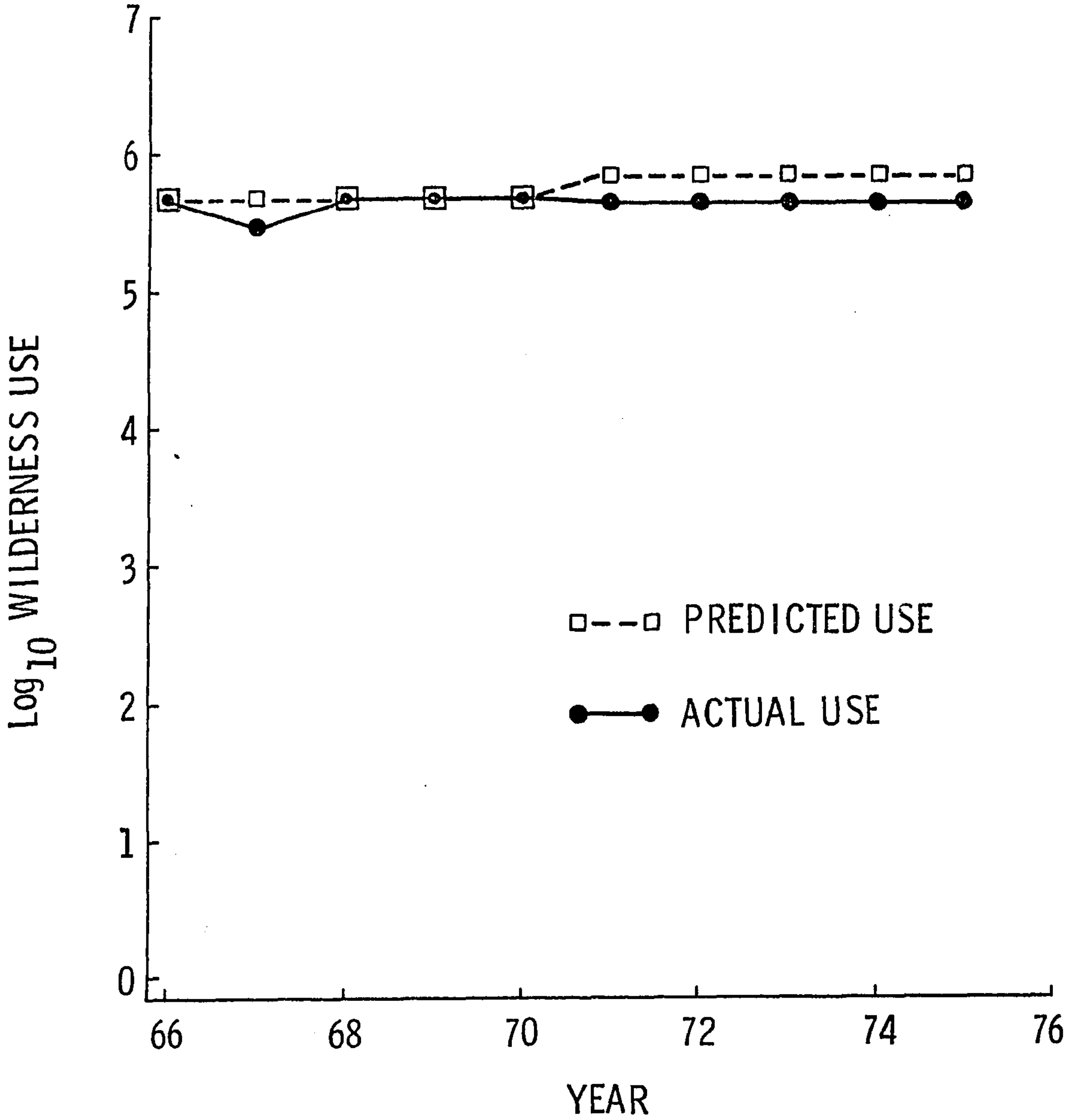


Figure 23. Region 1 predicted national use component and actual use for 1966 through 1975 using the model $LWU = \beta_0 + \beta_1 LWA + \beta_2 LNA + \beta_3 LPOP + \beta_4 LNPOP$

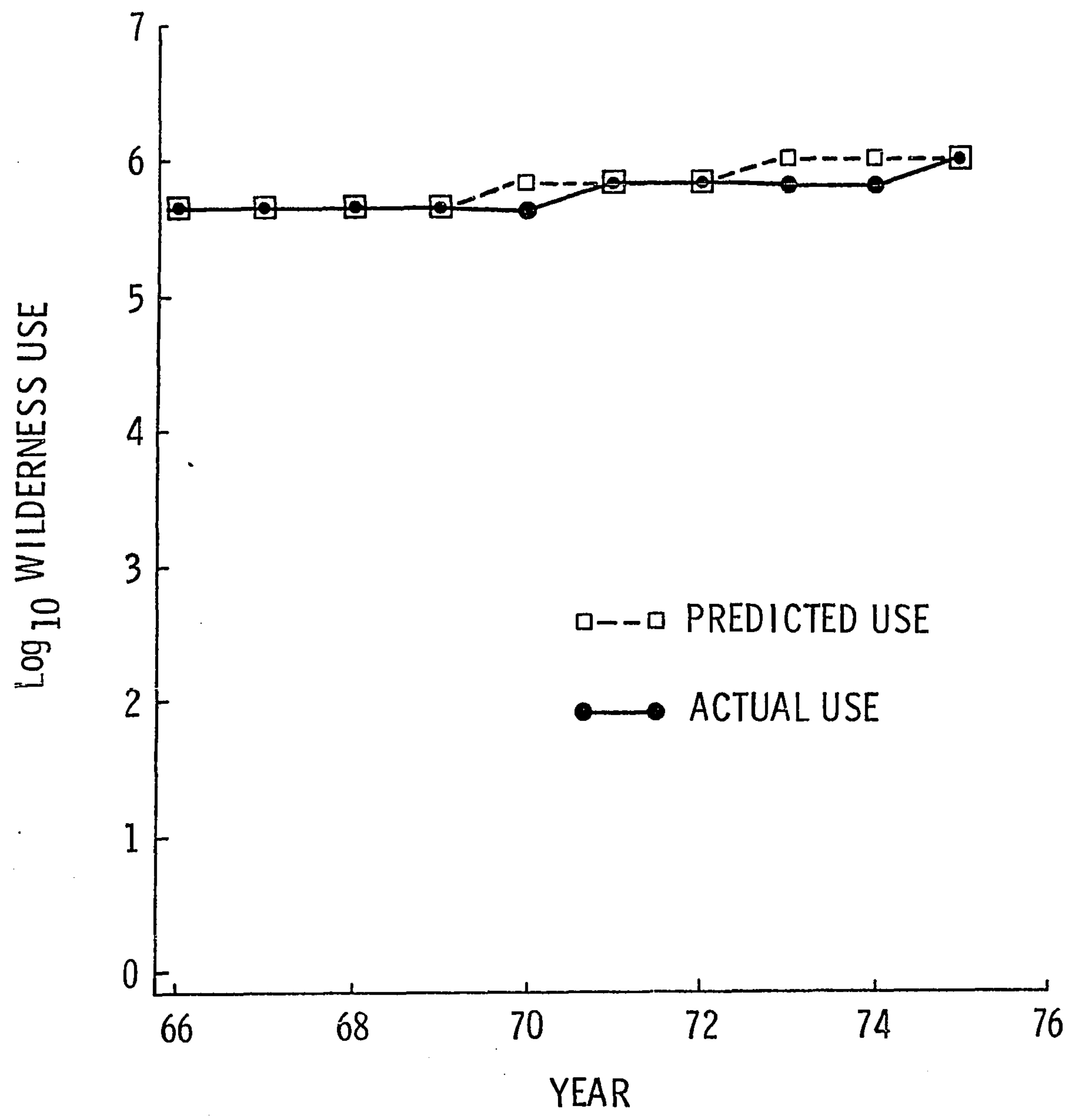


Figure 24. Region 2 predicted national use component and actual use for 1966 through 1975 using the model $LWU = \beta_0 + \beta_1 LWA + \beta_2 LNA + \beta_3 LPOP + \beta_4 LNPOP$

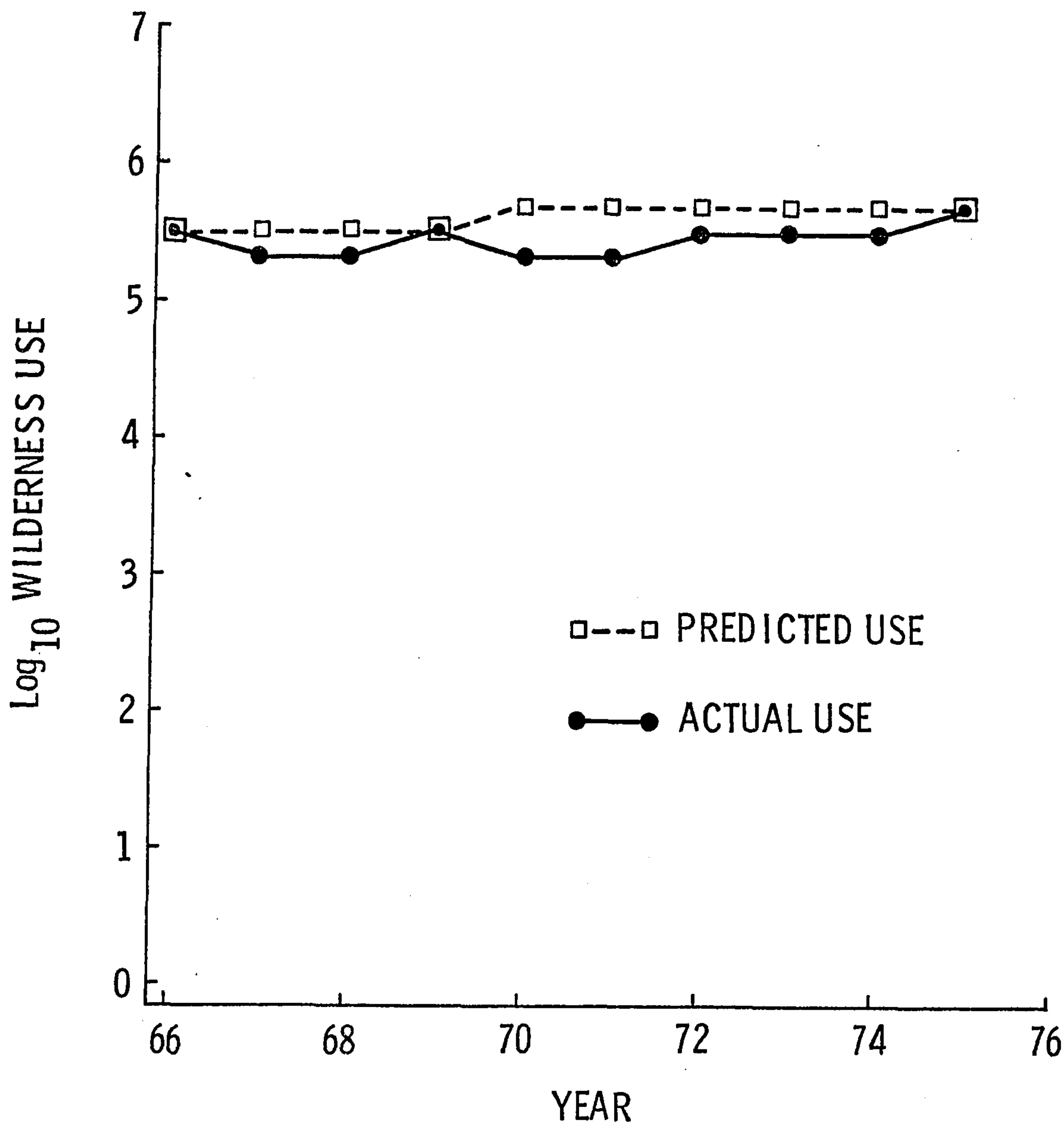


Figure 25. Region 3 predicted national use component and actual use for 1966 through 1975 using the model $LWU = \beta_0 + \beta_1 LWA + \beta_2 LNA + \beta_3 LPOP + \beta_4 LNPOP$

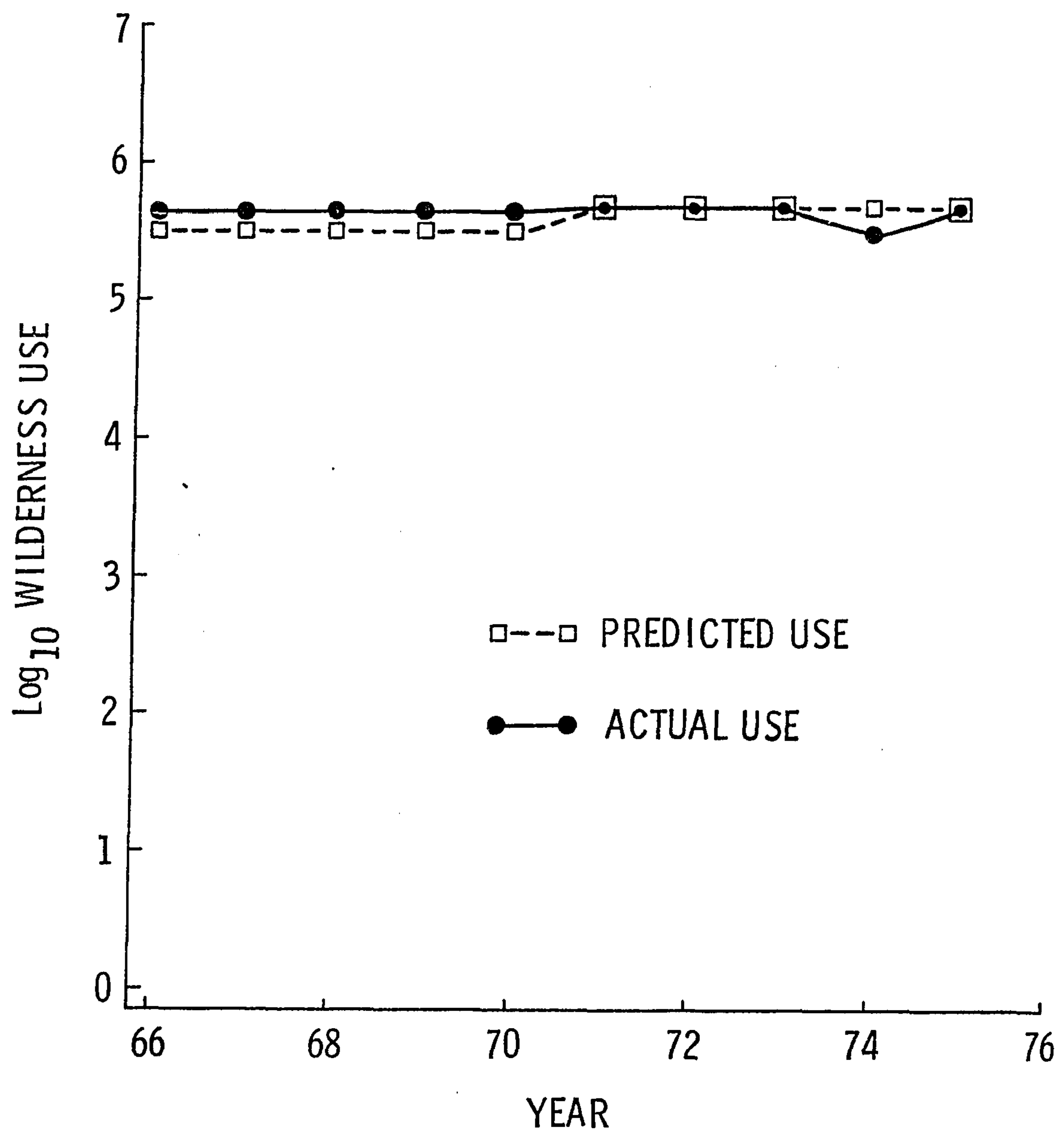


Figure 26. Region 4 predicted national use component and actual use for 1966 through 1975 using the model $LWU = \beta_0 + \beta_1 LWA + \beta_2 LNA + \beta_3 LPOP + \beta_4 LNPOP$

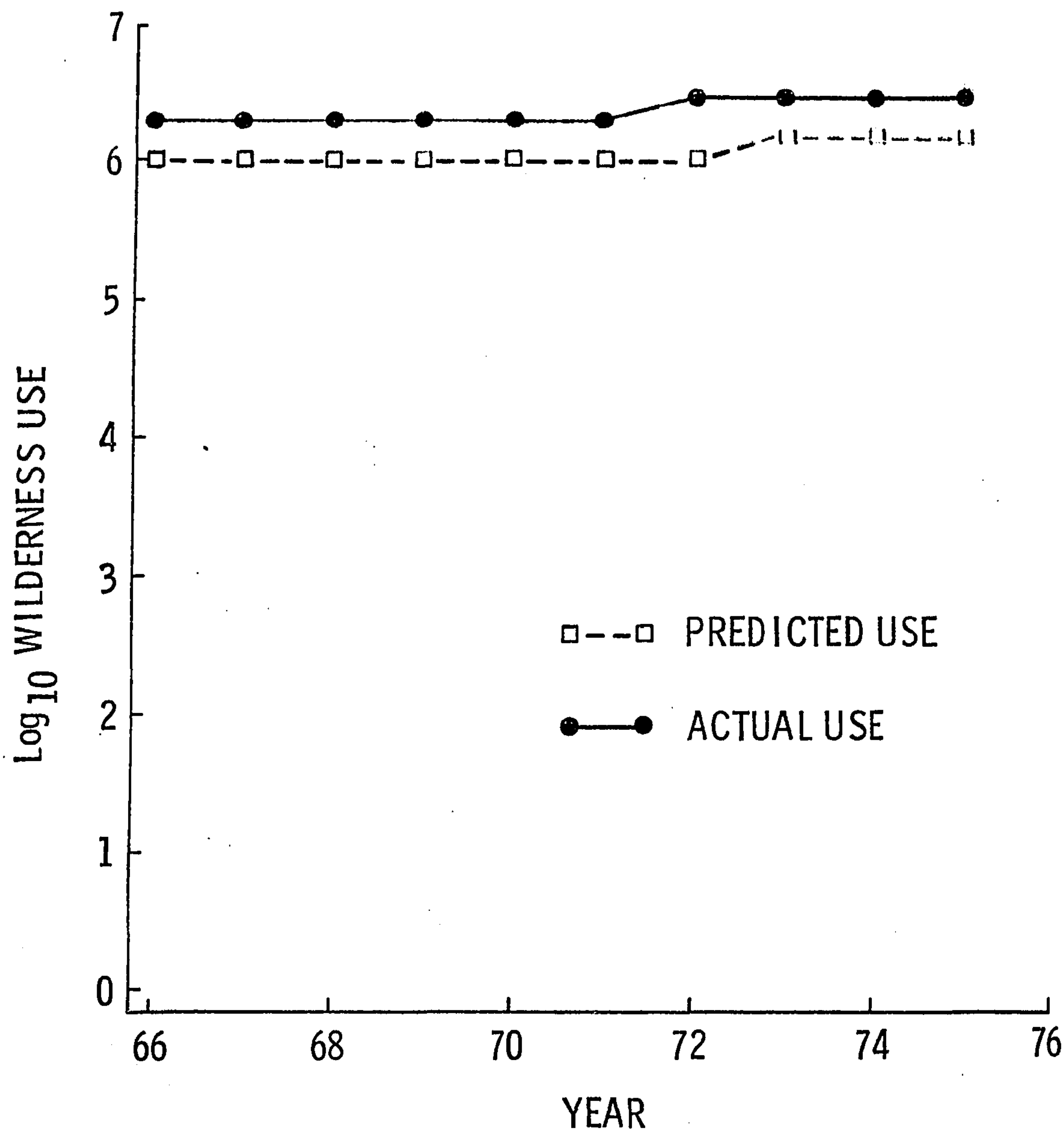


Figure 27. Region 5 predicted national use component and actual use for 1966 through 1975 using the model $LWU = \beta_0 + \beta_1 LWA + \beta_2 LNA + \beta_3 LPOP + \beta_4 LNPOP$

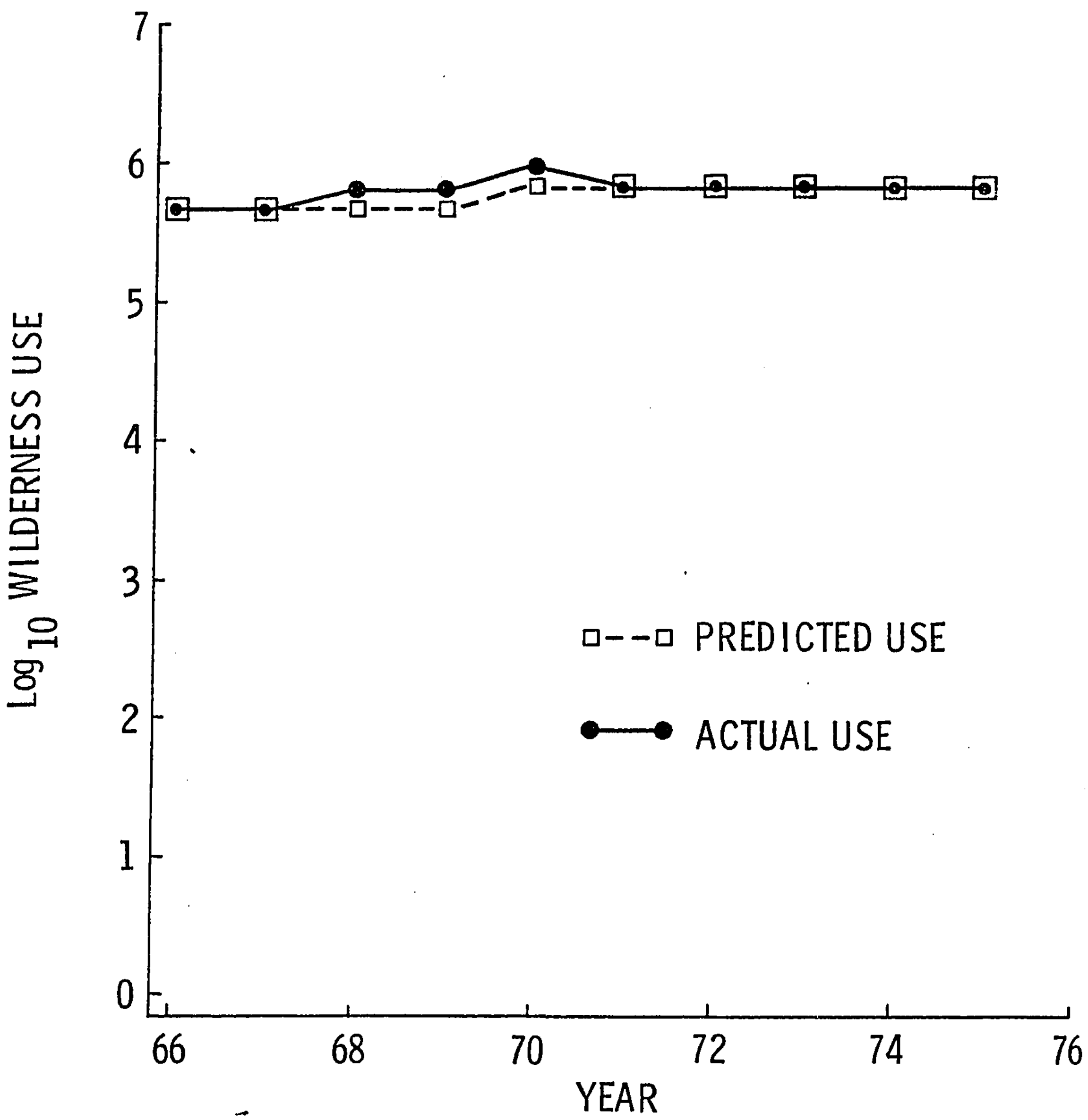


Figure 28. Region 6 predicted national use component and actual use for 1966 through 1975 using the model LWU = $\beta_0 + \beta_1$LWA + β_2LNA + β_3LPOP + β_4LNPOP

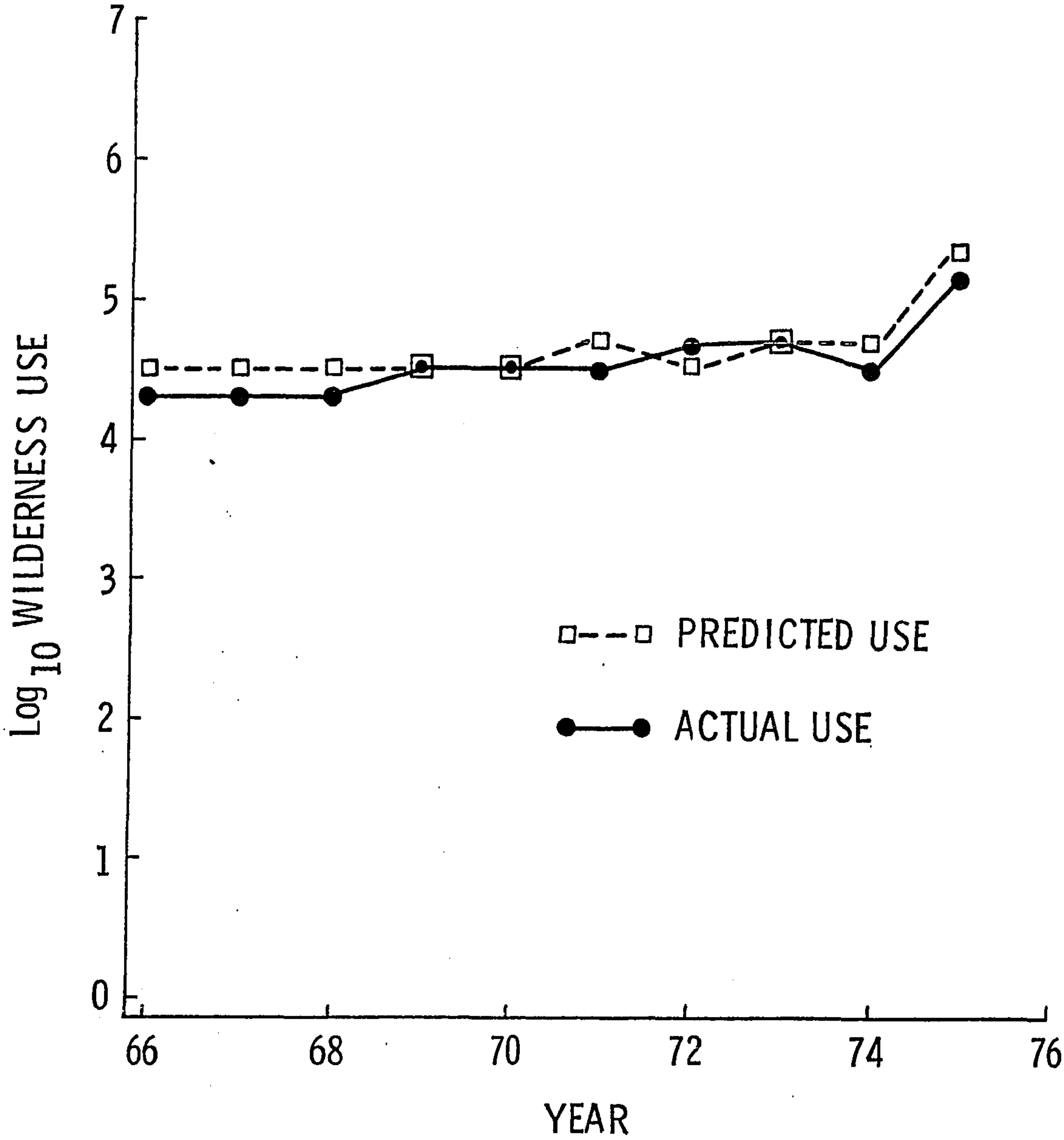


Figure 29. Region 8 predicted national use component and actual use for 1966 through 1975 using the model LWU = $\beta_0 + \beta_1 \mathrm{LWA} + \beta_2 \mathrm{LNA} + \beta_3 \mathrm{LPOP} + \beta_4 \mathrm{LNPOP}$

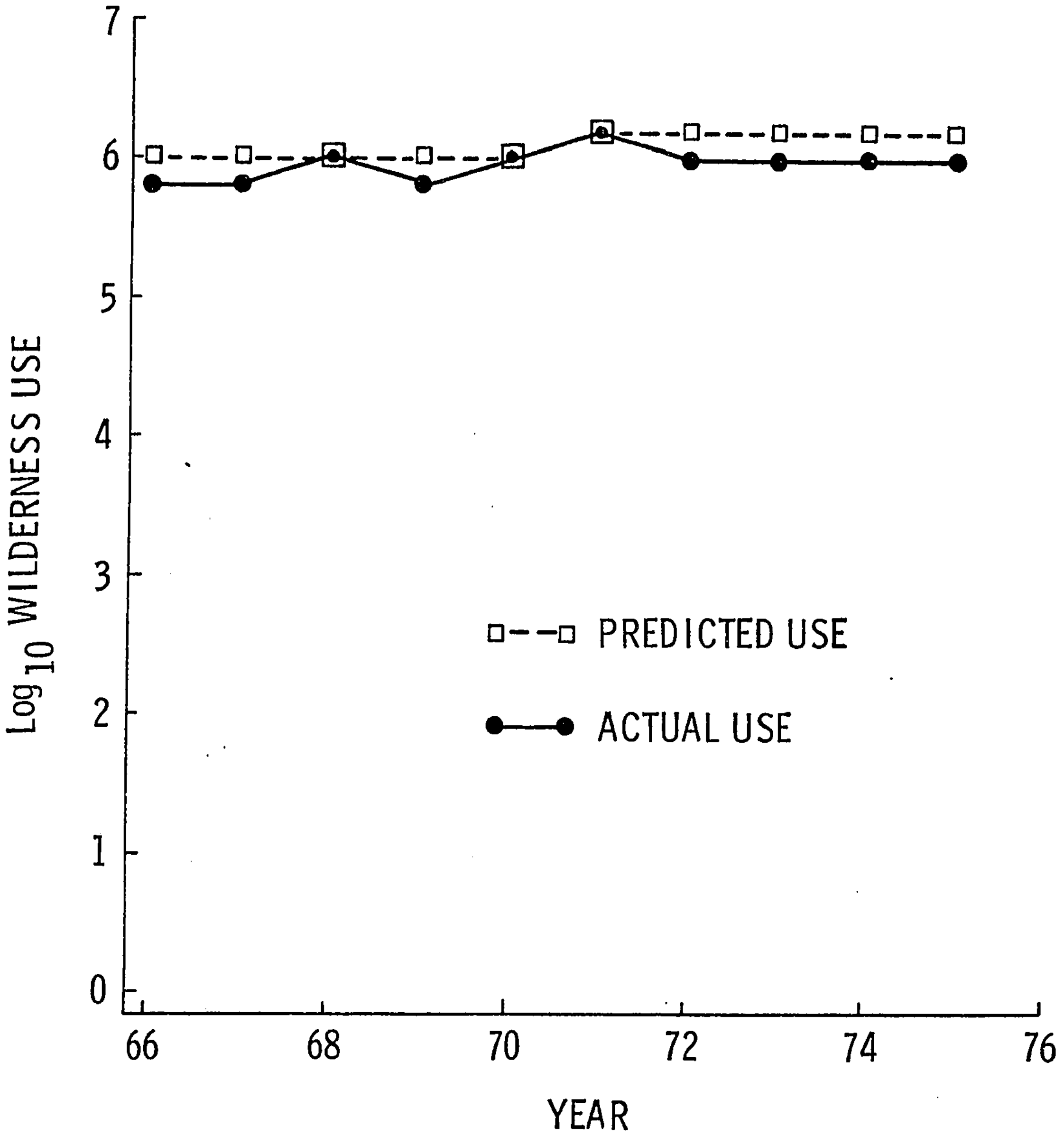


Figure 30. Region 9 predicted national use component and actual use for 1966 through 1975 using the model $LWU = \beta_0 + \beta_1 LWA + \beta_2 LNA + \beta_3 LPOP + \beta_4 LNPOP$

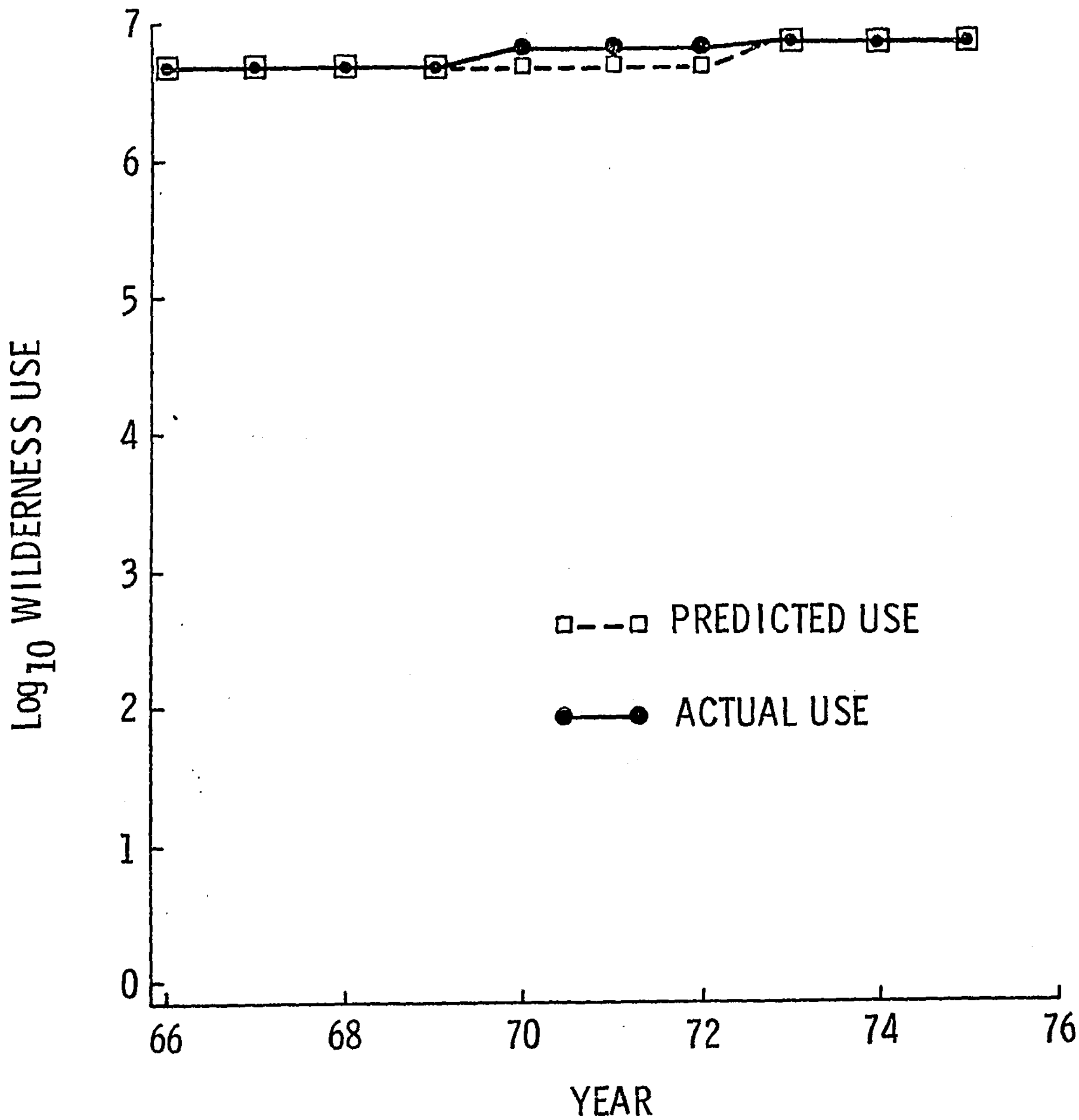


Figure 31. National total predicted and actual use for 1966 through 1975 using the model LWU = $\beta_0 + \beta_1$LWA + β_2LNA + β_3LPOP + β_4LNPOP

Projections

Projections of future use were made using this nonlagged model. Projected values for the independent variables in the model are the same as those used in the previous chapter. Tables 35 through 42 show regional unadjusted component projections for the model. Figure 42 shows the national projected trend for the model. A comparison of Figures 42 and 22 shows that projections based on scenario I are very similar for the two models but that projections based on scenarios II and III using the nonlagged model are consistently lower than those using the lagged model.

Two factors recommend the lagged use model over the nonlagged model. As indicated in Chapter V, the lagged use variable allows that model to adapt to changing use patterns not detectable by the nonlagged model. Additionally, before the nonlagged model can be used to project regional use, adjustments must be made in the intercept to include average regional residuals as explained in Chapter IV. For these reasons, it is recommended that the model developed in this chapter be used only when rough estimates of the trend in national wilderness use are desired.

Table 35. Region 1 unadjusted component of national wilderness use assuming three scenarios of wilderness area increase

Year	Scenario I	Scenario II	Scenario III
1980	5.889[a] (0.087)[b] 774[c]	5.889 (0.087) 774	5.889 (0.087) 774
1985	6.009 (0.100) 1,021	6.009 (0.100) 1,021	6.009 (0.100) 1,021
1990	6.119 (0.115) 1,315	6.265 (0.129) 1,841	6.203 (0.121) 1,596
2000	6.333 (0.148) 2,153	6.478 (0.155) 3,006	6.449 (0.153) 2,812
2010	6.554 (0.185) 3,581	6.700 (0.187) 5,012	6.671 (0.186) 4,688
2020	6.775 (0.223) 5,957	6.921 (0.222) 8,337	6.921 (0.222) 8,337

[a] $LWU = \beta_0 + \beta_1 LWA + \beta_2 LNA + \beta_3 LPOP + \beta_4 LNPOP$.

[b] Standard error of estimated $\overline{LWU}$.

[c] Projected visitor days (in thousands).

Table 36. Region 2 unadjusted component of national wilderness use assuming three scenarios of wilderness area increase

Year	Scenario I	Scenario II	Scenario III
1980	6.091[a] (0.086) 1,233[c]	6.091 (0.086) 1,233	6.091 (0.086) 1,233
1985	6.217 (0.098) 1,648	6.217 (0.098) 1,648	6.217 (0.098) 1,648
1990	6.334 (0.113) 2,158	6.409 (0.118) 2,564	6.376 (0.114) 2,377
2000	6.557 (0.145) 3,606	6.633 (0.146) 4,295	6.617 (0.145) 4,140
2010	6.788 (0.181) 6,138	6.863 (0.180) 7,295	6.847 (0.179) 7,031
2020	7.016 (0.219) 10,375	7.092 (0.216) 12,359	7.092 (0.216) 12,359

[a] $LWU = \beta_0 + \beta_1 LWA + \beta_2 LNA + \beta_3 LPOP + \beta_4 LNPOP$.

[b] Standard error of estimated LWU.

[c] Projected visitor days (in thousands).

Table 37. Region 3 unadjusted component of national wilderness use assuming three scenarios of wilderness area increase

Year	Scenario I	Scenario II	Scenario III
1980	5.701[a] (0.086)[b] 502[c]	5.701 (0.086) 502	5.701 (0.086) 502
1985	5.808 (0.099) 643	5.808 (0.099) 643	5.808 (0.099) 643
1990	5.905 (0.115) 804	6.039 (0.117) 1,094	5.979 (0.114) 953
2000	6.154 (0.146) 1,426	6.287 (0.145) 1,936	6.258 (0.144) 1,811
2010	6.384 (0.182) 2,421	6.517 (0.179) 3,289	6.489 (0.179) 3,083
2020	6.611 (0.219) 4,083	6.744 (0.215) 5,546	6.744 (0.215) 5,546

[a] $LWU = \beta_0 + \beta_1 LWA + \beta_2 LNA + \beta_3 LPOP + \beta_4 LNPOP$.

[b] Standard error of estimated LWU.

[c] Projected visitor days (in thousands).

Table 38. Region 4 unadjusted component of national wilderness use assuming three scenarios of wilderness area increase

Year	Scenario I	Scenario II	Scenario III
1980	5.902[a] (0.086)[b] 798[c]	5.902 (0.086) 798	5.902 (0.086) 798
1985	6.035 (0.099) 1,084	6.035 (0.099) 1,084	6.035 (0.099) 1,084
1990	6.158 (0.114) 1,439	6.441 (0.136) 2,761	6.330 (0.127) 2,138
2000	6.390 (0.145) 2,455	6.673 (0.158) 4,710	6.620 (0.153) 4,169
2010	6.628 (0.181) 4,246	6.911 (0.187) 8,147	6.858 (0.184) 7,211
2020	6.864 (0.218) 7,311	7.147 (0.220) 14,028	7.147 (0.220) 14,028

[a] $LWU = \beta_0 + \beta_1 LWA + \beta_2 LNA + \beta_3 LPOP + \beta_4 LNPOP$.

[b] Standard error of estimated LWU.

[c] Projected visitor days (in thousands).

Table 39. Region 5 unadjusted component of national wilderness use assuming three scenarios of wilderness area increase

Year	Scenario I	Scenario II	Scenario III
1980	6.612[a] (0.086)[b] 4,093[c]	6.612 (0.086) 4,093	6.612 (0.086) 4,093
1985	6.746 (0.098) 5,572	6.746 (0.098) 5,572	6.746 (0.098) 5,572
1990	6.870 (0.113) 7.413	6.957 (0.118) 9,057	6.917 (0.114) 8,260
2000	7.103 (0.145) 12,677	7.189 (0.146) 15,453	7.170 (0.145) 14,791
2010	7.340 (0.181) 21,878	7.427 (0.179) 26,730	7.408 (0.179) 25,586
2020	7.575 (0.218) 37,584	7.662 (0.215) 45,920	7.662 (0.215) 45,920

[a] $LWU = \beta_0 + \beta_1 LWA + \beta_2 LNA + \beta_3 LPOP + \beta_4 LNPOP$.

[b] Standard error of estimated LWU.

[c] Projected visitor days (in thousands).

Table 40. Region 6 unadjusted component of national wilderness use assuming three scenarios of wilderness area increase

Year	Scenario I	Scenario II	Scenario III
1980	6.082[a] (0.086)[b] 1,208[c]	6.082 (0.086) 1,208	6.082 (0.086) 1,208
1985	6.211 (0.099) 1,626	6.211 (0.099) 1,626	6.211 (0.099) 1,626
1990	6.330 (0.114) 2,138	6.463 (0.123) 2,904	6.405 (0.117) 2,501
2000	6.556 (0.146) 3,597	6.689 (0.149) 4,887	6.661 (0.148) 4,581
2010	6.788 (0.182) 6,138	6.920 (0.182) 8,318	6.893 (0.181) 7,816
2020	7.017 (0.219) 10,399	7.150 (0.217) 14,125	7.150 (0.217) 14,125

[a] $LWU = \beta_0 + \beta_1 LWA + \beta_2 LNA + \beta_3 LPOP + \beta_4 LNPOP$.

[b] Standard error of estimated LWU.

[c] Projected visitor days (in thousands).

Table 41. Region 8 unadjusted component of national wilderness use assuming three scenarios of wilderness area increase

Year	Scenario I	Scenario II	Scenario III
1980	5.395[a] (0.096)[b] 248[c]	5.395 (0.096) 248	5.395 (0.096) 248
1985	5.524 (0.104) 334	5.524 (0.104) 334	5.524 (0.104) 334
1990	5.645 (0.115) 441	6.172 (0.144) 1,486	5.994 (0.133) 986
2000	5.872 (0.142) 745	6.398 (0.162) 2,500	6.320 (0.158) 2,089
2010	6.106 (0.175) 1,276	6.633 (0.188) 4,295	6.554 (0.185) 3,581
2020	6.338 (0.211) 2,178	6.864 (0.218) 7,311	6.864 (0.218) 7,311

[a] $LWU = \beta_0 + \beta_1 LWA + \beta_2 LNA + \beta_3 LPOP + \beta_4 LNPOP$.

[b] Standard error of estimated LWU.

[c] Projected visitor days (in thousands).

Table 42. Region 9 unadjusted component of national wilderness use assuming three scenarios of wilderness area increase

Year	Scenario I	Scenario II	Scenario III
1980	6.276[a] (0.097)[b] 1,888[c]	6.276 (0.097) 1,888	6.276 (0.097) 1,888
1985	6.405 (0.107) 2,541	6.405 (0.107) 2,541	6.405 (0.107) 2,541
1990	6.506 (0.119) 3,206	6.598 (0.151) 3,963	6.558 (0.140) 3,614
2000	6.750 (0.147) 5,623	6.841 (0.171) 6,934	6.822 (0.167) 6,637
2010	6.981 (0.181) 9,572	7.073 (0.199) 11,830	7.054 (0.195) 11,324
2020	7.214 (0.217) 16,368	7.305 (0.230) 20,184	7.305 (0.230) 20,184

[a] $LWU = \beta_0 + \beta_1 LWA + \beta_2 LNA + \beta_3 LPOP + \beta_4 LNPOP$.

[b] Standard error of estimated LWU.

[c] Projected visitor days (in thousands).

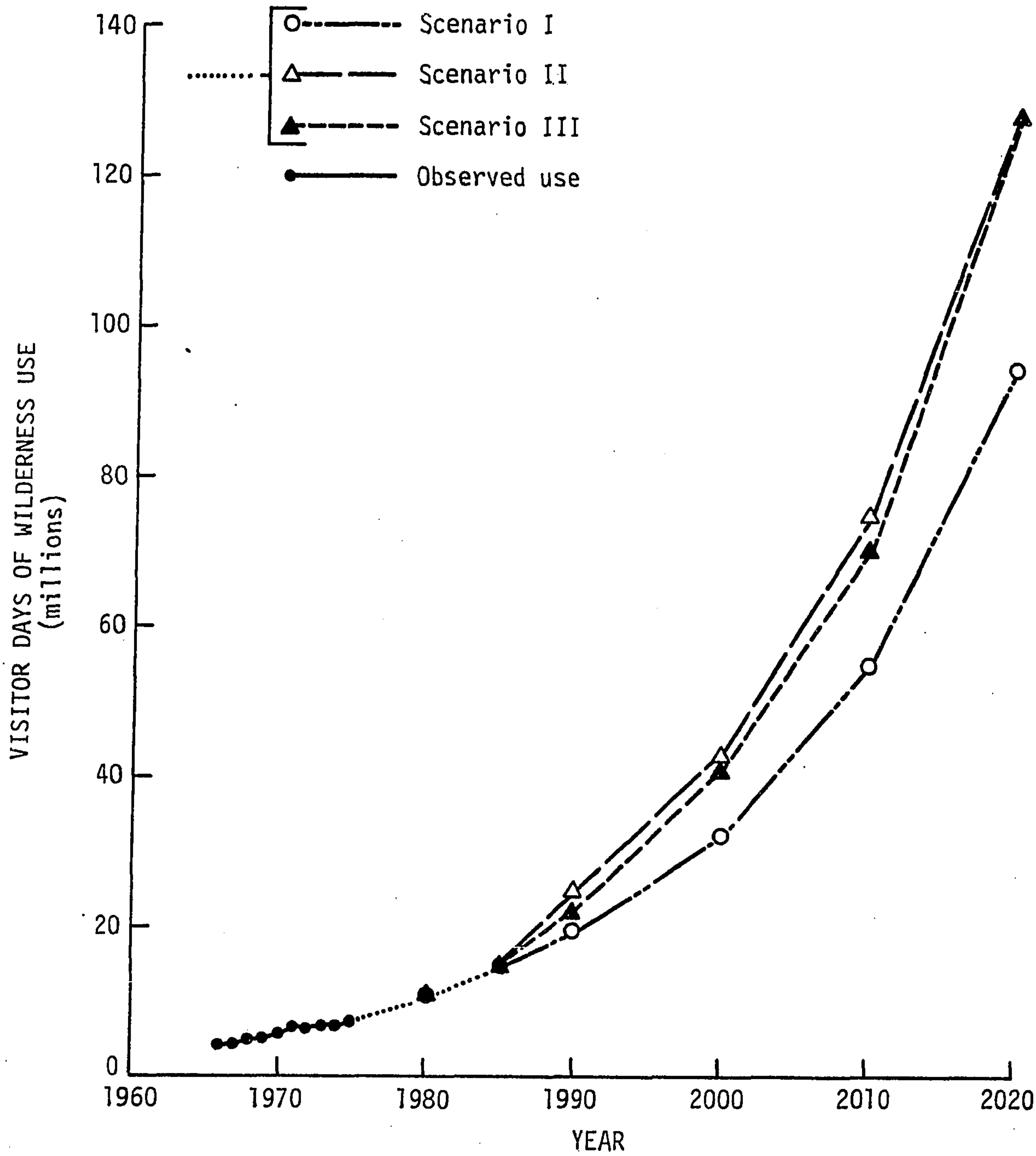


Figure 32. National trend in projected wilderness use using the model $LWU = \beta_0 + \beta_1 LWA + \beta_2 LNA + \beta_3 LPOP + \beta_4 LNPOP$ assuming three scenarios of wilderness area increase

CHAPTER VII. SUMMARY AND CONCLUSIONS

General

The primary objective of this study was to develop a model for use in projecting wilderness use on U.S. Forest Service wilderness areas. Because of time constraints, it was necessary that any models developed be based on existing data. As a secondary objective, deficiencies in existing data were to be pointed out.

Almost immediately, it became apparent that development of a typical regression model which relates socio-economic characteristics of wilderness users to their observed use levels would not be possible since existing data would not support such work. It was, therefore, necessary to base the models on wilderness use data, supply and demand variables, and median values for selected socio-economic characteristics.

Models Developed

Two major models were developed. The first modeled wilderness use as a function of regional wilderness acreage, regional population, median family income, and median male education. While this model does have the advantage of incorporating income and education variables which other studies have shown to be important in predicting recreation use, projections of these variables are not readily available for all years for which projections may be desired. This requires that trends in the variables be used to project them to future years. While this is not always undesirable, it is possible that variables projected on the basis of trend may be less reliable than those commonly projected by the Bureau of Census using other means.

The second model projects wilderness use as a function of regional wilderness acreage and regional number of areas, regional population, national population, and past wilderness use. The two population variables are much more readily available from Bureau of Census projections. Acreage and number of areas variables are available from U.S. Forest Service sources, and it was shown in Chapter IV that the lagged use variable can be accounted for in the model but not actually included in making projections. Thus, of the two, the lagged model should give the more reliable results.

The third model was presented as a modification of the lagged use model and is not intended for use except where rough estimates of national trend in future use are desired.

Figure 33 shows national trend in projected use for each of the three models developed assuming no increase in wilderness acreage or number of areas. The lagged and nonlagged models are in close agreement in terms of projected use while the time-series model gives much more conservative estimates of use. It should be reemphasized that both the lagged and nonlagged models fit the data better than does the time-series model and consequently would be expected to give more reliable results. Additionally, the lagged and nonlagged models both give projections more consistent with past trends in wilderness increase than does the time-series model. Over the 30-year period following World War II, wilderness use has increased at a rate of about

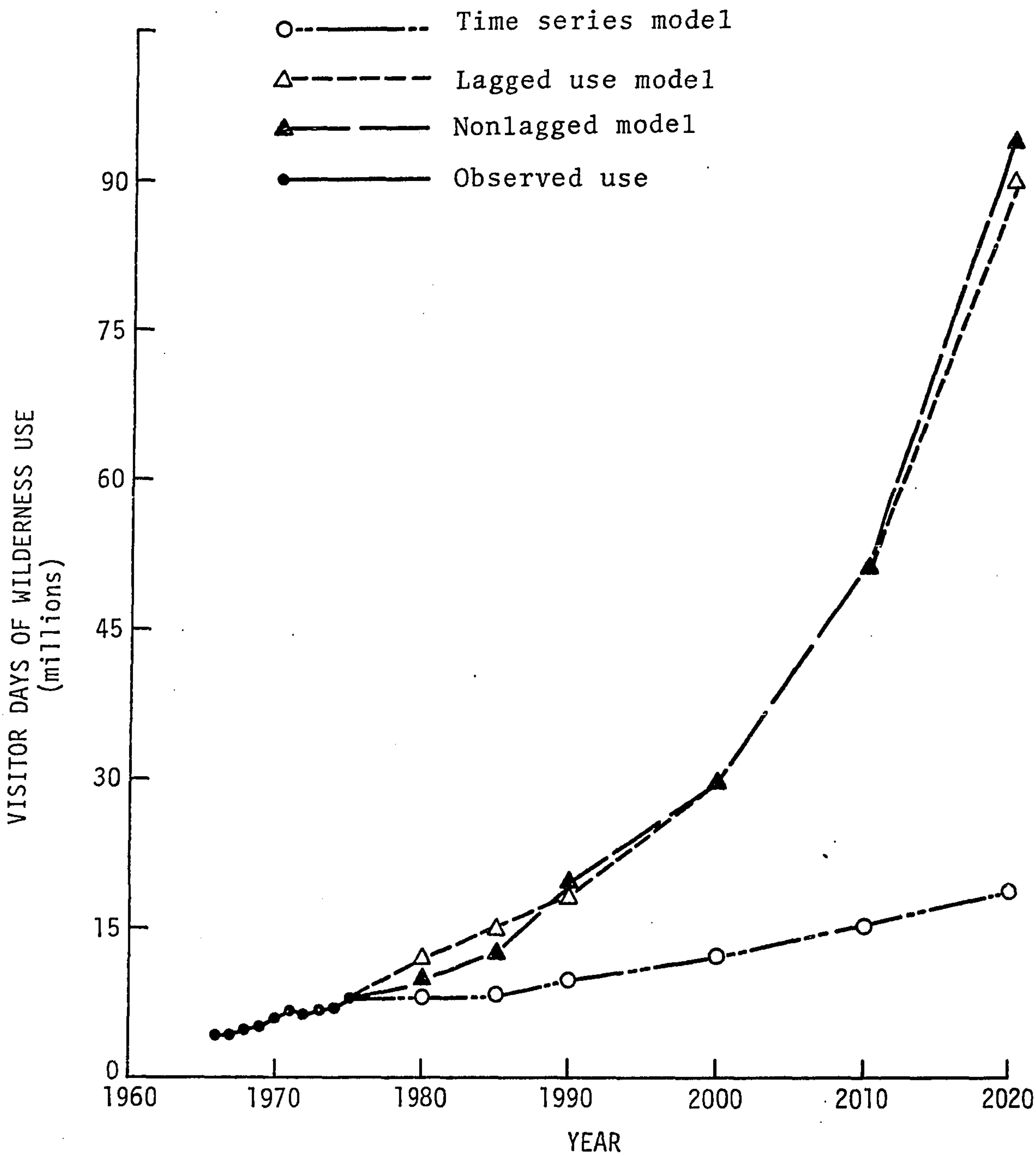


Figure 33. National trend in projected wilderness use for each model developed assuming no increase in wilderness acreage or number of areas

9½% per year. Both the lagged and nonlagged models project a rate of increase of approximately 5.6% per year to 2020. The time-series model, however, projects only a 2% yearly increase.

Need for Updated Regressions

By the nature of regression, the further the projection period from the mean of the data base, the less reliable the projection. Thus, while errors associated with projections for 1980, 1985, 1990, and 2000 are relatively small, they tend to become undesirably large for later years. Because of the ten-year incremental nature of the Resource Planning Act, however, an excellent opportunity is provided to update the regressions developed in this study. With each new assessment, the data base can be extended to include past years, and the regressions recalculated to develop a more accurate estimate of future use. This approach will also allow incorporation of the most recent Bureau of Census projections of socio-economic characteristics. It is, therefore, strongly recommended that such a course of action be followed in order to insure the most accurate use projections possible.

Other Data Considerations

In order for use projections of the nature presented in this study to be reliable, it is imperative that present use estimates for each wilderness area be as accurate as possible. Every effort should be made to insure that estimation techniques used on the various wilderness areas yield use estimates of the highest possible reliability.

It was mentioned that the no increase scenario used for all three models may underestimate actual use because of people being forced away from nonwilderness areas as the areas begin to develop under other uses. It would be desirable to better understand the magnitude of this impact on use in the remaining wilderness areas.
If use estimation could be initiated on several of the nonwilderness areas to determine how much use actually occurs there, such information could be incorporated into later projection models to give a better indication of what use may be after the wilderness system is completely designated.

Finally, a projection model which relates socio-economic characteristics of wilderness users to observed wilderness use will be possible only when such information has been consistently collected from representative wilderness areas over a period of years. Optimally, data on frequency of use, family income, age, and education could be collected for users in several wilderness areas, within each region for several years. As a minimum, such information could be collected from a number of areas within a single region. From this, it would be possible to develop a projection technique similar to those presented by Cicchetti and others and would almost certainly lead to improvements over the time-series model presented in this study.

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Finally, I deeply appreciate the understanding support of my wife Nancy and daughter Christa during the long period of graduate study.

APPENDIX 1

Tables 43 to 47 present the classification of wilderness users by family income classes for the wilderness studies cited in Chapter II.

Table 43. Number and percent of families observed by annual family income before taxes (Burch and Wenger, 1967)

Annual Family Income	Remote #	Remote %		All Oregon %
≤ 3,000	4	6.6		17.1
3,001- 5,999	14	23.0		34.5
6,000- 8,999	20	32.8		29.4
9,000-11,999	9	14.8	}22.8	} 15.0
12,000-14,999	5	8.0		
>14,999	9	14.8		4.0

Table 44. Percent of families observed by annual income of head of household before taxes (Lucas, 1964)

<table>
<tr><th rowspan="2">Income</th><th colspan="2">Canoeist</th><th colspan="2">Campers</th><th>Resort</th><th>Private</th><th>Day</th><th rowspan="2">National</th></tr>
<tr><th>Motor</th><th>Paddle</th><th>Auto</th><th>Boat</th><th>Guests</th><th>Cabin</th><th>Use</th></tr>
<tr><td>0- 1,999</td><td>0</td><td>0</td><td>0</td><td>2</td><td>1</td><td>0</td><td>0</td><td>15</td></tr>
<tr><td>2,000- 3,999</td><td>12</td><td>12</td><td>8</td><td>2</td><td>4</td><td>12</td><td>6</td><td>22</td></tr>
<tr><td>4,000- 5,999</td><td>30</td><td>21</td><td>34</td><td>55</td><td>15</td><td>16</td><td>44</td><td>23</td></tr>
<tr><td>6,000- 7,999</td><td>19</td><td>28</td><td>33</td><td>22</td><td>20</td><td>32</td><td>38</td><td rowspan="2">27</td></tr>
<tr><td>8,000- 9,999</td><td>11</td><td>9</td><td>9</td><td>10</td><td>8</td><td>6</td><td>6</td></tr>
<tr><td>10,000-14,999</td><td>19</td><td>16</td><td>12</td><td>7</td><td>30</td><td>17</td><td>0</td><td>9</td></tr>
<tr><td>15,000-24,999</td><td>3</td><td>9</td><td>4</td><td>2</td><td>13</td><td>11</td><td>6</td><td>3</td></tr>
<tr><td>25,000-49,000</td><td>6</td><td>5</td><td>0</td><td>0</td><td>8</td><td>6</td><td>0</td><td>1</td></tr>
<tr><td>≥50,000</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0.3</td></tr>
</table>

Table 45. Percent of users by annual income (Lucas, 1970)

Income	Jewel Basin Hiking Area	Middle Fork of the Flathead	Bob Marshall	Lincoln-Scapegoat	Cabinet Mountains	Spanish Peaks	Mission Mountains	National
≤ 3,000	5	3	2	4	4	7	3	8.9
4,000- 4,999	5	5	4	6	7	9	9	10.4
5,000- 6,999	15	6	10	12	16	8	9	11.8
7,000- 9,999	29	11	19	26	26	19	21	19.9
10,000-14,999	27	19	22	26	26	24	24	26.8
15,000-24,999	13	27	28	13	11	16	15	22.3
≥25,000	1	18	14	6	4	10	10	
No answer	5	11	3	9	6	8	7	

Table 46. Percent of users by total family income (O.R.R.R.C., 1962b)

Income	Bob Marshall	Gila	Great Smoky	Sierra	Mt. Marcy	BWCA	Yellowstone Teton
≤ 5,000	15	14	22	9	32	27	28
5,001- 7,999	28	43	38	23	27	18	25
8,000- 9,999	0	10	9	20	12	14	16
10,000-14,999	24	14	6	25	19	21	14
15,000-19,999	6	0	6	11	7	14	3
>20,000	27	19	19	12	3	6	14

Table 47. Percent of users by annual family income (Vaux, 1975)

Income Class	% Wilderness Visitors in Each Class	% Population California	% Population Nation
0 - 999	17.4	6.5	7.8
1,000 - 1,999	3.3	7.1	8.3
2,000 - 2,999	3.5	7.1	6.6
3,000 - 3,999	1.3	5.9	5.9
4,000 - 4,999	1.8	5.2	5.5
5,000 - 5,999	1.8	5.4	5.8
6,000 - 6,999	2.9	5.5	5.8
7,000 - 7,999	2.0	5.7	6.0
8,000 - 8,999	4.4	5.6	6.1
9,000 - 9,999	4.2	5.2	5.6
10,000 - 11,999	6.0	10.1	10.2
12,000 - 14,999	12.1	11.5	10.6
15,000 - 24,999	25.8	14.8	12.2
25,000 - 49,999	10.4	3.7	3.0
$\geq$ 50,000	3.1	0.7	0.6

APPENDIX 2

Tables 48 to 52 present the classification of wilderness users by years of educational attainment for the wilderness studies cited in Chapter II.

Table 48. Number and percent of husbands observed by years of education (Burch and Wenger, 1967)

Education Completed (Years)	Remote Camping #	%	All Oregon (25 years or over) %
≤ 8	3	5.1	35.7
9-12	19	32.2	43.9
13-16	22	37.3	15.7
≥17	15	25.4	4.7

Table 49. Comparison of educational attainment of national and regional populations and of wilderness users (Hendee _et al._, 1968)

<table>
<tr><th>Years</th><th>U.S. 1960</th><th>Wash-ington and Oregon 1960</th><th>Eagle Cap</th><th>Three Sisters</th><th>Glacier Peak</th><th>Eagle, Three Sisters, and Glacier Comb.</th><th>High Sierra 1960</th><th>BWCA 60-61</th><th>Three Sisters and Mt. Lakes 1962</th><th>N.F. Wilderness Users 1966</th></tr>
<tr><td>≤12</td><td>92.3</td><td>90.9</td><td>37.9</td><td>36.1</td><td>35.0</td><td>36.2</td><td>18.0</td><td>21.0</td><td>35.9</td><td>34.6</td></tr>
<tr><td>13-16</td><td rowspan="2">7.7</td><td rowspan="2">9.0</td><td>38.0</td><td>33.5</td><td>36.0</td><td>35.6</td><td>49.0</td><td>54.0</td><td>32.7</td><td>35.4</td></tr>
<tr><td>≥17</td><td>24.1</td><td>30.4</td><td>29.0</td><td>28.2</td><td>33.0</td><td>24.0</td><td>31.4</td><td>30.0</td></tr>
<tr><td># Reporting</td><td></td><td></td><td>343</td><td>513</td><td>490</td><td>1,346</td><td>179</td><td>----</td><td>474</td><td>848</td></tr>
</table>

Table 50. Percent of wilderness users by education level (Lucas, 1964)

Years	Canoeist		Campers		Resort Guests	Private Cabin	Day Use	National
	Motor	Paddle	Auto	Boat				
0- 8	13	0	12	9	10	11	20	50
9-11	13	4	10	28	8	17	7	15
12	23	17	43	38	37	23	63	22
13-15	15	12	15	9	13	17	10	8
16	25	42	14	13	24	19	0	5
≥17	11	25	6	3	8	13	0	

Table 51. Percent of wilderness users by years of education (Lucas, 1970)

Years	Jewel Basin Hiking Area	Middle Fork of the Flathead	Bob Marshall	Lincoln-Scapegoat	Cabinet Mountains	Spanish Peaks	Mission Mountains
1 - 4	0 %	0	0	0	0	0	0
5	0	0	0	0	1	0	0
6	0	0	1	1	0	1	1
7	1	0	1	1	1	0	0
8	4	3	2	2	1	1	3
9	4	1	7	4	7	2	3
10	5	1	2	4	8	5	8
11	8	4	5	5	7	3	3
12	29	28	21	29	25	21	15
13	86	6	6	8	7	9	4
14	6	5	7	10	13	10	7
15	6	4	4	5	4	7	5
16	9	23	11	9	8	8	12
$\geq$ 17	18	23	30	17	15	29	35
No Answer	1	3	2	3	1	1	0

Table 52. Percent of wilderness users by last grade in school completed (O.R.R.R.C., 1962b)

Years Completed	Bob Marshall	Gila	Great Smoky	Sierra	Mt. Marcy	BWCA	Yellowstone Teton
≤ 8	8	9	3	1	1	3	3
9 - 11	9	19	9	3	1	5	3
12	31	24	22	14	14	17	6
13 - 15	6	24	12	27	33	30	41
16	26	19	16	22	24	25	22
Post Grad	6	0	6	8	8	10	25
Advanced Degree	14	5	32	25	19	10	0

APPENDIX 3

Tables 53 to 57 present the classification of wilderness users by occupational status for the wilderness studies cited in Chapter II.

Table 53. Number and percent of husbands observed by occupational status (Burch and Wenger, 1967)

Occupation	Remote Camping #	Remote Camping %	Oregon
Professional and Technical	16	26.2	10.6
Upper Nonmanual (Managers, Proprietors)	7	11.5	14.0
Middle Nonmanual Clerical, Sales	13	21.3	13.3
Middle Manual Craftsmen, Foremen	10	16.4	20.2
Lower Manual (Operatives, Service, Laborers)	6	9.8	34.6
Farmers	6	9.8	7.3
Students	3	5.0	

Table 54. Number and percent of wilderness users by occupational status (Lime and Lorence, 1974)

Occupation	#	%
Professional Technical	559	44.6
Managers, Proprietors	82	6.5
Clerical, Sales	91	7.3
Craftsmen	178	14.2
Other Laborers	107	8.5
Students	237	18.9

Table 55. Percent of male users over 17 not presently in school by occupational status (Lucas, 1964)

Occupation	Canoeist Motor	Canoeist Paddle	Campers Auto	Campers Boat	Resort Guests	Private Cabin	Day Use	National
Professional, Technical	26	71	26	15	27	27	6	9
Farmers, Farm Mgr.	5	1	4	2	3	4	0	6
Proprietor, Manager, Official	32	13	17	2	30	4	0	12
Clerk, Sales	0	7	7	11	9	12	6	12
Skilled Laborer, Foreman	13	2	21	39	13	23	31	17
Other Lab. (Operatives, Service Workers, Laborers)	19	6	22	22	9	18	57	34
Retired	5	0	3	9	9	12	0	10
Students % of total	46	69	40	20	19	34	23	25

Table 56. Percent of wilderness users by occupational status (Lucas, 1970)

Occupation	Jewel Basin Hiking Area	Middle Fork of the Flathead	Bob Marshall	Lincoln-Scapegoat	Cabinet Mountains	Spanish Peaks	Mission Mountains
Professional	21	32	30	22	19	30	40
Farm Managers	1	4	2	5	0	3	1
Other Managers	5	15	11	6	2	2	3
Clerical	2	0	4	3	3	5	3
Salesworkers	4	11	4	3	1	2	2
Craftsmen	12	11	9	5	9	8	12
Operatives	7	3	6	5	7	2	3
Service Workers	1	0	1	1	2	2	1
Mine Workers	0	0	0	0	0	0	0
Laborers	3	3	3	2	6	0	2
Students	23	4	16	25	30	33	20
Housewives	13	9	9	8	9	7	9
Retired	3	4	1	3	3	1	2
Other	0	0	0	0	0	0	0
No Occupation	0	1	0	1	0	1	1
Military	0	1	2	7	2	1	0
Farm Workers	0	1	1	1	2	2	1
No Answer	3	1	3	3	2	2	1

Table 57. Percent of users by occupational status (O.R.R.R.C., 1962b)

Occupation	All	Bob Marshall	Gila	Great Smoky	Sierra	Mt. Marcy	BWCA	Yellowstone Teton
Free Professional	11	17	5	22	8	4	6	14
Salaried Prof.	39	9	29	35	32	45	29	14
Semi-Professional	5	0	0	0	8	1	1	11
Self-employed	7	17	0	3	6	3	5	3
High White Collar	19	29	0	0	13	14	24	19
Low White Collar	16	3	5	13	11	17	16	11
Skilled Wages	7	3	5	9	9	6	8	8
Unskilled Wages	8	14	10	6	7	2	9	3
Self-Emp. Farmer	5	9	33	3	1	1	1	8
Student	15	0	14	22	6	20	13	14
Retired	5	9	10	3	6	1	1	3
Housewife	--	--	--	--	--	--	--	--

APPENDIX 4

Tables 58 to 63 present the classification of wilderness users by age classes for the wilderness studies cited in Chapter II.

Table 58. Number and percent of wilderness users by sex and age (Burch and Wenger, 1967)

Age Group (years)	Female (Married) Remote Camping #	%	All Oregon %	Male (Married) Remote Camping #	%	All Oregon %
14-25	8	14	12.7	5	8.2	7.4
26-29	10	18	8.3	7	11.5	7.1
30-44	25	44	36.1	23	37.7	34.3
45-64	12	21	33.8	26	42.6	37.3
≥65	2	3	9.1	0	0	13.9

Table 59. Comparison of age distribution for Montana wilderness areas and U.S. population (Hendee et al., 1968)

Age Group (years)	0-15	16-18	19-24	25-34	35-54	55-64	65+
W.A. Users	3.1	6.7	12.1	24.4	46.2	5.7	1.7
U.S. Population 1960	32.8	3.7	7.8	12.8	24.0	8.7	9.2

Table 60. Percent of groups observed by age of group leader (Lime and Lorence, 1974)

Age of Leader	# of Groups	%
Under 20	112	8.7
20-34	618	48.0
35-54	469	36.5
55 or older	87	6.8

Table 61. Percent of users by age classes (Lucas, 1964)

Age	Canoeist Motor	Canoeist Paddle	Campers Auto	Campers Boat	Resort Guests	Private Cabin	Day Use	National
1 - 12	8	5	29	12	17	17	27	27
13 - 19	40	59	16	11	6	21	11	11
20 - 34	36	20	14	20	13	22	26	19
35 - 54	12	14	37	46	42	17	27	25
≥ 55	9	2	4	11	22	23	9	18

Table 62. Percent of wilderness users by age class for seven Montana areas (Lucas, 1970)

Age	Jewel Basin Hiking Area	Middle Fork of the Flathead	Bob Marshall	Lincoln-Scapegoat	Cabinet Mountains	Spanish Peaks	Mission Mountains
6 - 10	0 %	0	0	1	0	1	1
11 - 15	2	0	3	4	4	3	4
16 - 20	19	1	8	15	25	19	10
21 - 25	12	8	11	16	16	19	16
26 - 30	17	18	11	14	13	12	16
31 - 35	10	18	12	12	10	9	10
36 - 40	11	11	14	8	6	14	11
41 - 45	10	15	14	8	7	8	9
46 - 50	7	10	10	6	5	6	7
51 - 55	5	6	5	5	7	4	7
56 - 60	2	8	5	4	2	2	4
61 - 65	2	3	2	3	2	1	3
66 - 70	1	0	2	1	0	1	2
71 - 75	0	0	2	0	1	0	1
No Answer	1	3	1	2	2	0	0

Table 63. Comparison of percent of wilderness users by age class with U.S. population (O.R.R.R.C., 1962b)

Age	Mt. Marcy	BWCA	High Sierra	U.S. Population
19–29	40	36	21	29
30–49	48	54	59	54
$\geq$50	12	10	20	17